1. (a) (i) A = intraspecific
B = interspecific; 1

(ii) to show (growth) without competition/growth on its own; 1

(b) *Desmodium glutinosum* max 3
growth is greater with different species than with same species;
Desmodium nudyflorum
growth is greater with same species than with different species;
both species grew best in the absence of competition;
intraspecific competition has greater effect on D. *glutinosum* than D. *nudiflorum*;
interspecific competition has greater effect on D. *nudiflorum* than D. *glutinosum*;

[5]

2. (a) Use of quadrats;
randomly placed;
Estimate percentage of area shaded/covered by heather; 3

(b) (i) Fewer seedlings survive;
Fewer plants reach maturity;
Flower heads not produced / flower heads eaten;
therefore less seeds produced; max 2

(ii) Two marks for correct answer 87 %;
If incorrect, one mark for correct calculation of total seed production
fenced area = 9652
unfenced area =1290 2

[7]

3. (a) Definition of niche referring to where organism found;
and role; 2

(b) (i) Only species A found / species B does not survive; 1

(ii) Both species present;
Species A confined to temperatures below 16°C 2

[5]

4. (a) Identification of abiotic factor which would affect maize growth;
Method of measuring gives appropriate quantitative data/at intervals; 2

(b) Reduce light;
Reduce water;
Reduce mineral ions;
Reduce wind;
Increase humidity;
Reduce temperature (by shading); max 2

(c) Maize and beans have different niches / different nutritional requirements / use different minerals;
Exploit environment more effectively;
As take water/mineral ions from different depths in soil; max 2

[6]

5. (a) The number of different plants / organisms of each species present;
Total number of species/plants of all species; 2

(b) Harsh / more extreme / less stable environmental conditions at start;
Such as dry sand / high salt content / low nitrate / humus;
Few **species** able to tolerate these conditions; max 3

[5]

6. (a) Use of quadrats;
randomly placed;
Estimate percentage of area shaded/covered by heather; 3

(b) (i) Fewer seedlings survive;
Fewer plants reach maturity;
Flower heads not produced / flower heads eaten;
therefore less seeds produced; max 2

(ii) Two marks for correct answer 87 %;
If incorrect, one mark for correct calculation of total seed production
fenced area = 9652
unfenced area =1290 2

[7]

7. (a) (i) Beechwood = 73.3% / 73%, Hedge = 34.7% / 35%;
(*Rounding to significant figures must be correct, e.g. not 34%*) 1

(ii) To compare different numbers collected from the two sites;
and show whether differences significant/ not just due to chance /
to confirm or reject null hypothesis; 2

(b) Random / not biased to one colour; 1

(c) Predators find brown snails more easily in hedge than in beechwood; 1

(d) Detritivores break leaves into small pieces / increase surface area;
Deposit faeces;
Increases rate of microbial action;
Bacterial fungi decompose / break down leaves or organic matter;
Secretion of enzymes for digestion;
Absorption of sugars;
Respiration by detritivores/ microorganisms;
Release of carbon dioxide;
Carbon dioxide used in photosynthesis; max 7

[12]

8. (a) suitable number of quadrats used;
(many/ large number/ 10 minimum)
count all the squares occupied (by the leaves of) one species;
reference to randomising;
description of a method of randomising any 2

(b) (ii) 62 of 100 squares occupied by leaves,
= 62%; 1

(ii) reduces wind effect/ shelters the plants;
creates shade/keeps the temperature more constant;
increases humidity of air;
changes the pH next to the hedge; any 2

(c) choice suitable traps/pitfall trap;
(*allow a description of a trap*)
description of setting reference to collection times;
(*allow either a time of day or a time left before collecting sample*)
reference to random placing of traps in both locations;
reference to comparison of similar sized areas in the locations;
(eg. number per m^2)
reference to statistical/chi square test;
reference to how result of statistical test indicates a relationship/difference;
capture and mark individuals;
estimation of population size at different times of the year;
description of capture/ recapture method of estimating population; 6

[12]

9. (a) use of large numbers of quadrats in each area (*if number stated then 10+*);
random sampling method (*e.g. grid + random numbers*)/systematic sampling method (*allow regular sampling along a transect*);
counting.
OR
(*allow capture/recapture method*
mark and release;
recapture;
calculate proportion of marked snails in second sample) 3

(b) use of indicator OR meter OR probe (*litmus neutral*);
detail e.g. obtaining soil solution (*damp soil neutral*
(*allow reasoning detail on use of probe*) 2

(c) prevents desiccation/keeps moist;
hidden from predators 2

(d) salty water has more negative water potential than fresh water;
osmotic effects of this on roots/water passes out 2

[9]

10. (i) Range 28 – 32%; (answer must relate to the method)
system for counting e.g. seven or eight squares in total; 2

(ii) Use of grids/coordinates;
Table of random numbers; 2

[4]

11. (a) random sampling method;
use of large numbers/many/10 or more quadrats in each area;
counting daisies and dividing by area; 3

(b) the cutting has no effect; 1

(c) daisy, dandelion, buttercup show (statistically) significant differences;
no significant effect on plantains;
comment on relative significance of daisy/dandelion/buttercup;
regular cutting linked to significant increase in density of daisy/dandelion;
linked to significant decrease in density of buttercup; 3 max
(*no marks if significance idea omitted*)

[7]

12. (a) generation of random co-ordinates;
use of 10 or more quadrats;
collection of all dog whelks in quadrat; 3

(b) greater variation for sheltered population/population A;
range/spread around the mean; (*or converse*) 2

(c) (i) smaller ratio means relatively larger foot/population B has relatively large foot;
better able to grip;
larger/longer shells have greater area exposed/are subject to greater force;

(ii) wave action limits the max. L/A ratio/extremes;
valid point about age, e.g. greater age range on sheltered shore/live longer on sheltered shore;

(*allow shell size marking point in either* (*c*)(*i*) *or* (*c*)(*ii*) *but only credit once*) 4 max

[9]

13. (a) there is no difference between the number of lichens growing on the walls (facing different directions); 1

(b) 36, 36, 36; 1

(c) 2; 1

(d) p less than 0.05;
reject the null hypothesis;
the difference is not due to chance/significant difference;
the direction the wall faces does have an effect on the population of lichens; 3 max

(e) algae photosynthesise/ produce organic molecules /named;
fungus anchors the lichen / absorbs water which is available to the algae/
prevents dehydration of alga /absorbs mineral ions/ phosphates/nitrates; 2

[8]

14. (a) (i) transect line may not go through representative areas /may avoid certain areas; 1

(ii) large sample;
how random coordinates are generated / how random places chosen; 2

(b) (i) spread of values around the mean height of the plant; 1

(ii) smaller plants at higher altitude;
greater the altitude the lower the standard deviation ;
reference to figures to make a comparison; 2 max

(iii) the plants measured were grown under uniform conditions; 1

[7]

15. (a) species present change the habitat/named change;
other species able to colonise;
new species better competitors; 3 max

(b) D - as more species present;
more complex food webs;
change in one species will have little effect on others;
as alternative food sources; 2 max

(c) sand drains easily/low water retention;
(sunken stomata) reduce transpiration;
as pocket pf saturated air trapped near stomatal pore;
this reduces diffusion/water potential gradient; 3 max

(d) series of changes over a distance;
gradient of environmental factor/named environmental factor/cline present;
ensures sampling of each community; 1 max

[9]

16. (a) use of random numbers to place quadrats;
number of individuals counted in large number of quadrats;
little variation random, large variation - clustered; 3

(b) new plants grow attached to parent; 1

(c) less competition;
for water/nutrients; 2

[6]

17. (a) (i) Two marks for correct answer of 1760 (seals per year)
One mark for incorrect answer showing clear evidence of calculating rate by dividing number by time; 2

Q *Note that working mark cannot be awarded unless method is shown clearly and unambiguously*

(ii) Fewer whales means more krill;
More krill-feeding fish;
More food for seals; 2 max

(b) Data can be collected rapidly;
Does not require defining individual plants; 2

(c) Change in species composition;
Greater area of bare ground;
Lower diversity; 3

Q *Credit should not be given for imprecise answers relating to "plants".*
Final point requires specific reference to diversity

(d) Seals produce nitrogenous waste/urine/faeces;
Produces ammonium ions/nitrates by decomposition/nitrification; 2

[11]

18. (a) (i) Avoid bias/can only apply statistical test/Hardy-Weinberg expression to randomly collected data; 1

(ii) Give credit for any method which would ensure collection of a random sample from trees e.g. beating tray; 1

Q *Note that specification does not require specific knowledge therefore the use of specific terminology such as "beating tray" is not required here.*

(b) Two marks for correct answer of 49% red and 51% black;
One mark for incorrect answer in which p/frequency of black allele/B is Identified as 0.3 and q/frequency of black allele/B as 0.7; 2

(c) (i) Increase in the frequency of the red/b allele from autumn to spring/in all years;
Therefore frequency of black/B allele decreased and fewer black ladybirds in spring; 2

Q *The terms allele and gene must be used correctly but penalise only once*

(ii) Black ladybirds would become more active so respiration rate increases;
Deplete food reserves; 2

[8]

h**19.**(a) 1 Sample of ground beetles captured and counted (a);
2 Released and second sample captured;
3 Count total number of beetles (B) and number marked (b);
4 Total population (A) estimated from the relationship $\frac{a}{A} = \frac{b}{B}$;
5 Detail of method e.g. pitfall trap/marking with tippex;
6 Refinement to ensure greater accuracy e.g. large number/ marking in position such that does not affect survival; 5 max

(b) 1 Mowing prevents growth of woody plants;
2 By cutting off growing point;
3 The longer the interval between mowing, the further succession can progress;
4 With frequent mowing diversity of plants will be less;
5 Fewer insect inhabitants/niches available; 5

Q *Since this is an ecological question, use of appropriate ecological terminology is expected. Credit such terms as producer, consumer, habitat, and niche. Do not credit inappropriate terminology such as "places" to live and "fighting for food".*

(c) 1 Higher carbon dioxide concentration at night/during darkness;
2 Photosynthesis only takes place during light;
3 Photosynthesis removes carbon dioxide and respiration adds carbon dioxide;
4 Respiration taking place throughout 24 hours;
5 Quantitative consideration such as that in plants overall photosynthetic rate greater than respiration rate;
6 Human effect such as additional carbon dioxide from heavy daytime traffic/street lighting could prolong photosynthesis; 5 max

[15]

20. (a) limited space/food; 1

(b) on mid-shore B more successful/B better competitor;
B removed C from rocks/B grew faster/ B obtained more food than C;
or
on upper shore C more successful/C better competitor;
C removed B from rocks/C grew faster/ C obtained more food than B; 2

(c) larvae unable to obtain food/desiccate/predated; 1

(d) (i) substances released from adults; 1

(ii) larvae settle in favourable environment; 1

[6]

21. (a) (i) Water and carbon dioxide/H_2O and CO_2; 1

(ii) Releases energy on breakdown/hydrolysis;
Uses energy from other reactions to form;
Can be readily moved/stored/broken down when needed;
Allows energy to be released in suitable amounts; max 2

(b) (i) RuBP + CO_2 →(2) GP; 1

(ii) RuBP still being produced;
But no carbon dioxide for it to react with/to form GP; 2

[6]

22. (a) Multiple alleles only involve one gene/one locus/polygene more than one gene: 1

(b) (i) T^AT^A and T^AT^O; 1

(ii) T^B and T^C; 1

(c) (i) Phenotypes of parents (Inhibitors) A and B (Inhibitor) B;
Genotypes of parents T^AT^B T^BT^O;
Genotypes of offspring T^AT^B T^AT^O T^BT^O T^BT^B: 3

(ii) Assess probability;
of results being due to chance; 2

or Significant difference;
Between O & E/from Null hypothesis;

(d) Random sampling/known area;
Weighing all plant material (finding dry mass of plants); 2

(e) (i) Percentage in each case is 9 – 10, 7.5 – 12.5;
Energy in each case is 36 – 40kJ 3 – 5kJ; 2

or 0.36 → 0.4% 0.027 → 0.05%
36 → 40kJ 2.5 → 5kJ

(ii) **Any two from**

Lost as heat; in respiration; movement; excreted material:
egested/not all digested:
not all eaten; 2

[14]

23. (a) Respiratory loss;
Heat;
Undigested / gone to symbiont; max 2

(b) 87 400 ÷ 7 140 000 × 100 = 1.2% 1

(c) Supply of inorganic molecules / e.g. CO_2 / nitrate / phosphate / minerals; 1

[4]

24. (a) Heather; 1

(b) Secondary consumers are parasites/small size/rapid reproductive cycle/ clearly explained example; 1

(c) (i) 3.3 (%)/ 3.3 recurring; 1

(ii) (Energy lost via)
Heat/respiration;
movement/muscle contraction/named activity;
faeces/indigestible material/not all eaten;
excretion/examples; max.2

[5]

25. (a) (i) Correct answer (0.5%) awarded two marks;;

answer involving decimal point in wrong place but derived correctly / correct working only awarded 1 mark 2

(ii) Some fails to encounter chloroplasts/chlorophyll in producers (e.g. some absorbed by water);
reflection;
inappropriate wavelength; max. 2

(b) Only a certain amount of light energy available / not enough energy left;
respiratory loss between each trophic level / loss in faeces; 2

(c) Incorporated in tissues of decomposers;
passed on to other organisms in decomposer food chain;
lost in respiration by decomposers; max. 2

(d) (i) Excites/raises energy level of electrons;
which pass to carriers/leave chlorophyll; 2

(ii) Fall in production of triose phosphate/no more triose phosphate produced;
triose phosphate production requires ATP/reduced NADP;
produced during passage of electrons along electron transport chain; 3

(e) Energy is available more rapidly because released in single reaction / does not go through as many processes;
ATP releases its energy in small/manageable quantities; 2

(f) (i) Activity / needs of cell linked to level of ATP / ADP ;

link made between high level of one and low level of the other;
level of ADP linked to electron transport and ATP production; 3

(ii) Energy released as heat;
because not used to produce ATP; 2

[20]

26. (a) Energy losses due to radiation / evaporation / transpiration / in photosynthesis / energy of wrong wavelength / some of energy is heat;
Extras: cancel 1

(b) 2920; 1

(b) (Ammonium) → nitrite;
Nitrite → nitrate;

OR

Ammonium → nitrate; (*1 mark only*)

If symbols: correct symbols
e.g. ammonium (*nitrate* (NO_3) = *NO MARKS*

By nitrifying bacteria / *Nitrosomonas* / *Nitrobacter* / nitrification;
By oxidation / using oxygen / aerobic; 3 max

[5]

27. (a) *Any two from*:

Wrong wavelength / some = heat / UV / used to evaporate water;
Reflected;
Misses chloroplasts / is transmitted;
Inefficiency of photosynthesis / energy loss in photosynthesis / ref. other limiting factor; 2 max

(b) Energy losses (at each trophic level) / energy use;
In named process – e.g. excretion / egestion / movement / respiration / … / as heat; (NOT „*growth*" – *CANCEL*, *ignore „waste"*)
Not available / (too) little left to sustain higher trophic levels / to be passed on; 3

[5]

28. (a) (Energy release) only involves a single reaction/one-step/
(energy released) in ATP → ADP (+Pi)/
energy transfer direct to reaction requiring energy; 1
[*Ignore: reference to speed*] [*Reject: "not many steps"*]

(b) Any **two** from:
Need more ATP (than can be produced in photosynthesis)/not enough;
Photosynthesis cannot produce ATP in dark;
Cannot be produced in cells lacking chlorophyll/chloroplasts/
ATP cannot be transported; max 2

(c) Glycolysis/anaerobic respiration/"fermentation";
Does not occur in mitochondria/takes place in cytoplasm; 2

[5]

29. (a) (i) P = C – R – U– F / C – (R + U + F) / eq; 1

(ii) 3.74; 1

(b) Correct answer: 2.18 (*Accept 2.19 or 2.2*)
/ correct for candidate's (a)(ii) ;; = 2 marks

Correct use of data but wrong answer:

$$\frac{\text{(a)(i)} \times 10^6 \times 100}{21135 \times 8100}$$ = 1 mark 2

(c) Less energy lost as heat / in maintaining body temperature / in movement; 1

[5]

30. (a) May/June/July; 1

(b) Loss of energy/heat/use of energy/loss of materials/loss of mass;
By respiration/movement/excretion/excreta/egestion/egesta
IGNORE "waste" REJECT "growth"
Less energy/mass/matter left to sustain higher level/to be passed on
inedible parts/Non-digestible parts; 3

(c) Phytoplankton reproduce at rate ≥ rate of their consumption; 1

[5]

31. (a) light is wrong colour/frequency/wavelength/does not strike chlorophyll molecule/chloroplasts/there is another limiting factor; 1

(reject light is reflected/ is lost as heat and use as cancel)

(b) energy is lost in respiration;
(small amount is) lost as heat;
lost to decomposers/lost in excretion/leaf fall/death and decay;
part of oak tree not eaten/not digested; 2 max

(c) each bird has several/many parasitic mites;
but total mass/energy of mites is less than that of one bird; 2 max

[5]

32. (a) collect a sample (of insects in each area) and mark unobtrusively/in a way not harmful to insects;
release and allow time to re-integrate with rest of population/eq.;
collect second sample and count number marked;
number in population estimated by:

$$\frac{S1 \times S2}{\text{Number marked in } 2^{nd} \text{ sample}} \quad / \quad /$$

$$\frac{\text{Total marked}}{\text{Number marked in } 2^{nd} \text{ sample}} = \frac{\text{Population}}{\text{second sample}}; \quad 4$$

(b) (i) 1; 1

(ii) (p =) 0.05/ 5%; 1

(ignore 95%)

(iii) value for χ^2 exceeds critical value/ 125.8 > 10.8 ;
Results unlikely to be due to chance/ have a biological cause;
P <0.1% / < 5% ; 2 max

(c) (i) biomass respired/ GPP – respiration = NPP;
biomass lost as CO_2; 2

(ii) more food for insects; 1

(iii) decomposers/ saprotrophs;
release enzymes and digest detritus/
substances found in detritus/ eq.;
absorb products of digestion/ suitable e.g. that relates to candidates 2nd point;
respired and CO_2 released;
used by plants in photosynthesis/ enters leaves; 4 max

[15]

33. (i) Population is the total number of organisms/individuals of a species/tigers in an area (at a given time); 1

(ii) (Deforestation involves) habitat destruction/ destruction of niches;

Some prey animals move out or die / fewer suitable prey for tiger/ less food for tiger; Reduces tiger population if prey biomass falls below 600 (tonnes per km^2); 3

[4]

34. (a) (i) pyramid correctly drawn and labelled;
ignore organic matter 1

(ii) energy lost/not transferred between trophic levels;
in respiration /as heat / in excretory products / movement;
ignore in urea / in faeces. „Growth" cancels 2nd marking point only 2

(b) (i) decomposers convert (nitrogen in organic compounds) into ammonia/ammonium;
suitable example of "organic nitrogen" - protein/urea/amino acid etc. (e.g. linked to process);
nitrifying bacteria / correctly named convert ammonium to nitrate;
via nitrite; 3 max

(ii) convert nitrogen (gas) into ammonium / ammonia / amino acids;
add usable/available nitrogen to an ecosystem / eq.; 2

(c) (i) 1. numbers of dispersed bacteria increase as they feed on organic matter;
2. numbers of free-swimming protoctistans increase because number of bacteria increase;
3. dispersed bacteria decease as amount of dispersed organic matter decreases / due to lack of food / as organic matter is converted to flocs;
4. decrease as are preyed on by free-swimming protoctistans;
5. decrease in free-swimming protoctistans due to lack of dispersed bacteria; 3 max

(ii) 1. (in a succession) organisms (enter an area and) change the environment/conditions;
2. creating new niches / habitats;
3. allows different species / different types of organisms to enter / be successful;
4. dispersed bacteria change dispersed organic matter to floes;
5. presence of flocs allows crawling protoctistans to enter / to increase / to be successful; 4 max

[15]

35. (a) (i) (collect and) dry all above ground plant material;
(reject collect one/ small sample/whole plants)
in an oven at or just below 100 ^{o}C;
weigh and repeat until constant mass;
other precaution, e.g. cooling in desiccator; 3 max

(ii) large number of sample areas / repeats;
randomly selected; 2

(iii) drying destroys plants, so different samples needed;
large area, so difficult to get representative samples;
difficult to measure biomass of trees;
variability in growing conditions;
variability of abiotic conditions in different areas of forest; 2 max

(b) (i) 1:25 1

(ii) most of the plants are trees/large;
high proportion of dead / non-photosynthesising biomass;
herbs grow rapidly/small so large percentage increase;
herbs have higher productivity, so ratio lower at 10 years; 2 max

[10]

36. (a) pyramid labelled with names of trophic levels; 1

(b) energy lost at each trophic level/step;

due to respiration/heat loss/other valid reason;
fewest steps means least energy loss max. 2

(c) herring numbers may decrease a little
as barnacles only part of diet;
or
herring numbers may decrease a lot
as both barnacles and sand eel numbers decreased; 2

[5]

37. (a) Few planktonic organisms / algae (to intercept light);
Because few nutrients added; 2

(b) (i) Mutualism / symbiosis; 1

(ii) Algae photosynthesise;
Take in carbon dioxide;
producing carbohydrates / named / carbohydrate which coral can utilise; 3

(c) Increase in concentration of nitrates / phosphates;
From sewage / organic pollution / effluent (from increasing tourist industry);
Stimulation of seaweed / plant growth;
Seaweed covers coral preventing light reaching algae;
Seaweed prevents tentacles of coral setting up feeding current;
Increased number of (planktonic) algae (increases cloudiness);
Less light able to penetrate to algae in coral; max 6

[12]

38. (a) (i) Energy in nutrients absorbed from gut; 1

(ii) M = N + R/N = M - R/ R = M - N; 1

(b) If in heated shed less energy spent on maintaining temperature/movement;
This energy available for growth; 2

(c) Energy lost at each stage in food chain so
longer food chain for beef less efficient; 1

[5]

39. (a) Phospholipid;
Part of cell membrane;
or
ATP/ADP;
ATP as source of energy for specific process;
ADP needed to produce ATP/needed in specific process;
or
Nucleic acids/DNA/RNA;
Carry genetic information/involved in protein synthesis; max 4

Other valid examples may he accepted. Mark according to principles illustrated above.

(b) (i) Both rise to a peak then fall;
Peak is earlier in plants;
Fall in plants due to death of tissue/consumption by herbivores/dilution with non-radioactive phosphorus/rise in herbivores as they eat plants:
Fall in herbivores as they are eaten by carnivores:
Herbivore peaks later as takes time to pass through plants first; max 4

(ii) Decompose organic compounds/phosphorus containing compounds/
Release phosphates; 1

(c) Form carbohydrates/sugars by photosynthesis;
Carbohydrate is respired;
Carbon dioxide is lost;
Some will form cellulose;
Is not digested/lost in faeces; max 3

[12]

40. (a) (i) 3, 40, 2.5 1

(ii) released in respiration; (*reject: stored in fat*)
dissipated / „lost" as heat. 2

(iii) (high proportion of) indigestible material, e.g. cellulose. 1

(b) (i) mammal maintains high/constant body temperature;
high rate of heat loss / high rate of metabolism / respiration, or energy, required to maintain body temperature.
(*refs to size neutral*) 2

(ii) higher rate of muscular activity / more effort to catch food. 1

[7]

41. (a) kJ m^{-2} y^{-1} (*all 3 units needed - accept J, any area, any time*) 1

(b) 0.19 / 0.186 gains 2 marks
(*evidence of* (*1.5/807*) *X 100 gains 1 mark/0.2 with no working gains 1 mark*) 2

(c) (i) light/sunlight 1

(ii) by protoctists;
and by their consumers;
and by decomposers
transfer (to environment) as heat/thermal energy;
combustion of fossilised remains 3 max

[7]

42. (a) (i) Correct answer given as a ratio (1000: 1) = 2 marks;;
Principle- graph readings 950 and 0.95 or principle of division = 1 mark 2

(ii) Respiration/energy loss/heat loss between trophic levels;
Only some of energy in hare blomass converted to predator biomass, e.g. energy used by predators to catch hares;
Only some of the energy in hare biomass passed on, e.g. not all parts edible; 2 max

(b) (i) Predator numbers initially constant before increasing/increase after delay;
Slower rate of increase/decrease;
Plateau, rather than peak; 2 max

(ii) Influence of food supply, e.g. increase as shrubs increase;
Influence of predators;
Influence of shrubs becoming toxic, so numbers decrease; 3

[9]

43. (a) 8°C – 24°C (*accept 7.5 to 8.4 and 23.5 to 24.4*)*;* 1

(b) Photosynthesis rate only just above respiration rate;
Little gain in biomass *or* net loss in biomass due to (night-time) respiration;
No excess production for storage in tubers; 2 max

(c) Optimum for enzymes exceeded/ enzymes denatured;
Light independent reaction disrupted; 2

(d) Suitable instrument – e.g. thermistor/diode probe/soil thermometer; 1
Practical detail of use e.g. consistent depth of readings/bulb at level of tubers; 1
Regular *or* standardised measurements/data logger; 1

[7]

44. (a) (i) 63 (kJ m^{-2} day^{-1}); 1

(ii) $\frac{125}{5150} \times (100)$; (*principle – divide products by radiation*)
2.43/2.4%; (*correct answer award 2 marks*) 2

(b) some light reflected/ not absorbed/refracted (if qualified) back into atmosphere;
some light misses chloroplasts/chlorophyll;
only certain wavelengths of light used (in photosynthesis); 2 max

(c) 20/21 – 27/28 °C;
greatest difference between photosynthesis and respiration; 2

[7]

45. (a) stickleback and dragonfly nymphs; 1

(b) (i) shape – at least 4 levels – early summer (correct shape)
2^{nd} level widest,
autumn – correct pyramidal shape;
shows 5 levels – labels producer, primary consumer, secondary consumer; 2

(ii) mass unit per unit volume or unit area/mass, e.g. kg dm^{-3} or kg m^{-2}; 1

(d) some energy lost at each stage in the food chain / transfer of energy not 100% efficient / lost in respiration;
only a limited amount of energy is available / each stage less available for next stage / little energy left at top of food chain; 2

[6]

46. (a) (i) herbivore = $\frac{11-12}{24-26} \times 100 = 42.3 - 50\%$

carnivore = $\frac{6}{24-26} \times 100 = 23 - 25\ \%$

(*correct method* $\frac{measurement}{total}$ = *1 mark*)

(*correct answer = 2 marks*) 2

(ii) cellulose present in faeces;
cellulose/much of food indigestible;
indigestible material contains energy; 2 max

(b) (smaller mammals) have a larger SA:V ratio;
so lose more heat (*linked to size*);
maintains body temperature (*linked to higher rate of respiration*); 2 max

[6]

47. (a) (i) 2860–2970; 1

(ii) $\frac{\text{answer to(i)}}{1417500} \times 100$; = 0.2 % - 0.21%;;

(*correct answer = 2 marks*)

principle of $\frac{\text{mean energy in heater}}{\text{energy absorbed}}$; = 1 mark 2

(iii) energy lost as heat/by respiration/metabolic processes;
qualified comment on the inefficiency of photosynthesis
e.g. 25% efficient/energy lost as electrons passed on;
carbon dioxide/temperature limiting; 2 max

(b) only a proportion of heather eaten/not all plants eaten/energy lost in decay;
not all food eaten is digested/energy lost in faeces;
heat/energy lost due to respiration; 3

[8]

48. (a) transmission / reflected / misses chlorophyll/chloroplasts / wrong wavelength; 1

(b) the energy is transferred to / absorbed by / incorporated into decomposers / named decomposer;
stored in / used in growth of decomposers;
respiration (of decomposers);
released as heat;
or
energy stored in fossil fuels;
combustion;
released as heat; 3 max

(c) (larger area) to absorb light;
(larger surface area) to absorb carbon dioxide;
short diffusion pathway for gases/ oxygen/CO_2;
light able to penetrate to all cells; 2 max

(d) effect;
detail;
effect on photosynthesis; 3
some effects are less light /light absorbed by water
different wavelength of light
temperature
availability of carbon dioxide
availability of water

(more than one effect award 1 mark only)

[9]

49. (a) decomposers/detritus feeders/saprotrophs/saprotrophic bacteria or fungi; 1

(b) kJm^{-2} $year^{-1}$; 2

(allow m^{-3})

(two correct units gains 1 mark

(all three correct gains 2 marks)

(c) light reflected;
light misses chlorophyll/chloroplast/transmission through leaf;
wrong wavelength;
respiration (by primary producer);
inefficiency of photosynthesis; 3 max

[6]

50. (a) secondary – algae → limpet → starfish

OR

plant plankton → mussel → starfish,
tertiary – plant plankton →animal plankton → barnacle

OR

mussel → starfish; 1

(b) use of random numbers;
large number of quadrats;
count number of dead and live mussels in unit area; 3

(c) (i) different size organisms/different composition (of carbohydrate/fat/protein)/
low digestability/not all eaten; 1

(ii) 14; 1

[6]

51. (a) less nitrate taken up;
less amino acid/protein synthesis;

OR

parts of plant higher in protein die;
higher proportion of cellulose/non-protein components in diet; 2

(b) (wildebeest) selective feeders/only some species/parts of plant eaten;
choose to eat species/part of plant with high protein content; 2

(c) named protein;
consequences of lack of protein related to failure to escape from predators;

examples:

myosin/actin;
(skeletal) muscles weak/less muscular tissue so slower movement;

OR

relevant named enzyme;
why deficiency of enzyme increases chance of being caught;

OR

haemoglobin;
insufficient oxygen for muscle contraction; 2

[6]

52. ***General Principles for marking the Essay:***

Four skill areas will be marked: scientific content, breadth of knowledge, relevance and quality of language. The following descriptors will form a basis for marking.

Scientific Content(maximum 16 marks)

Category	Mark	Descriptor
Good	16 14 12	Most of the material reflects a comprehensive understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. Some material, however, may be a little superficial. Material is accurate and free from fundamental errors but there may be minor errors which detract from the overall accuracy.
Average	10 8 6	Some of the content is of an appropriate depth, reflecting the depth of treatment expected from a programme of A-level study. Generally accurate with few, if any, fundamental errors. Shows a sound understanding of the key principles involved.
Poor	4 2 0	Material presented is largely superficial and fails to reflect the depth of treatment expected from a programme of A-level study. If greater depth of knowledge is demonstrated, then there are many fundamental errors.

Breadth of Knowledge(maximum 3 marks)

Mark	Descriptor
3	A balanced account making reference to most areas that might realistically be covered on an A-level course of study.
2	A number of aspects covered but a lack of balance. Some topics essential to an understanding at this level not covered.
1	Unbalanced account with all or almost all material based on a single aspect.
0	Material entirely irrelevant or too limited in quantity to judge.

Relevance(maximum 3 marks)

Mark	Descriptor
3	All material presented is clearly relevant to the title. Allowance should be made

	for judicious use of introductory material.
2	Material generally selected in support of title but some of the main content of the essay is of only marginal relevance.
1	Some attempt made to relate material to the title but considerable amounts largely irrelevant.
0	Material entirely irrelevant or too limited in quantity to judge.

Quality of language(maximum 3 marks)

Mark	Descriptor
3	Material is logically presented in clear, scientific English. Technical terminology has been used effectively and accurately throughout.
2	Account is logical and generally presented in clear, scientific English. Technical terminology has been used effectively and is usually accurate.
1	The essay is generally poorly constructed and often fails to use an appropriate scientific style and terminology to express ideas.
0	Material entirely irrelevant or too limited in quantity to judge.

[25]

Guidelines for marking the essay

Introduction

The essay is intended for the assessment of AO4 (Synthesis of knowledge, understanding and skills) and Quality of Written Communication (Sections 6.4 and 6.5 in the specification).
Examiners are looking for

- evidence of knowledge and understanding at a depth appropriate to A level
- selection of relevant knowledge and understanding from different areas of the specification
- coverage of the main concepts and principles that might be reasonably be expected in relation to the essay title
- connection of concepts, principles and other information from different areas in response to the essay title
- construction of an account that forms a coherent response
- clear and logical expression, using accurate specialist vocabulary appropriate to A level

Assessing Scientific Content

Maximum 16 marks.
Descriptors are divided into 3 categories: Good (16, 14, 12), Average (10, 8, 6) and Poor (4, 2, 0). Only even scores can be awarded, i.e. not 15, 13, etc.
Examiners need first to decide into which category an essay comes.

A good essay

- includes a level of detail that could be expected from a comprehensive knowledge and understanding of relevant parts of the specification
- maintains appropriate depth and accuracy throughout
- avoids fundamental errors

- covers a majority of the main areas that might be expected from the essay title (These areas will be indicated in the mark scheme). (Occasionally a candidate may tackle an essay in an original or unconventional way. Such essays may be biased in a particular way, but where a high level of understanding is shown a high mark may be justified.)
- demonstrates clearly the links between principles and concepts from different areas.

Note that it is not expected that an essay must be „perfect" or exceptionally long in order to gain maximum marks, bearing in mind the limitations on time and the pressure arising from exam conditions.

An average essay
- should include material that might be expected of C/D/E grade candidates
- is likely to have less detail and be more patchy in the depth to which areas are covered, and to omit several relevant areas
- is likely to include some errors and misunderstandings, but should have few fundamental errors
- is likely to include mainly more superficial and less explicit connections

A poor essay
- is largely below the standard expected of a grade E candidate
- shows limited knowledge and understanding of the topic
- is likely to cover only a limited number of relevant areas and may be relatively short
- is likely to provide superficial treatment of connections
- includes several errors, including some major ones

Having decided on the basic category, examiners may award the median mark, or the ones above or below the median according to whether the candidate exceeds the requirements or does not quite meet them.

Marking the essay

In marking scientific content, letters in the margin show each key area covered; these are used to assess the breadth of criteria. A single tick is used to indicate accurate coverage of each significant area, and a double tick to emphasise „good depth of content." Errors are indicated with a cross. A squiggly line in the margin is used to highlight irrelevance and „Q" to highlight poor use of terminology, unclear grammar and inappropriate style.

Specific guidance for assessing Scientific Content and Breadth of Knowledge in Essays

The following provides guidance about topics which might be included in the essays. It is not an exclusive list; the assessment of scientific content does not place restrictions on topics that candidates might refer to, provided they are

- relevant;
- at an appropriate depth for A level and
- accurate.

It is not expected that candidates would refer to all, or even most, of the topics to gain a top mark; the list represents the variety of approaches commonly encountered in the assessment to the essays. In both essays, topics either from the option modules or beyond the scope of the specification should also given credit where appropriate.

Breadth of Knowledge

3 marks	four topics - at least one from each set of examples
2 marks	four from one set of topics three topics - at least one from each set
1 mark	two topics

53. (a) climax; 1

(b) change in habitat/environmental conditions by the species present;
making it less suitable for existing species/more suitable for other species;
reference to competition; 2

(c) (i) succession stopped (at herbaceous perennial stage);
young trees/shrubs eaten;

(ii) succession stopped due to destruction/burial of all vegetation present;
succession begins again each year; 3

[6]

54. (a) (i) Always within tolerance / optimum range for <u>both</u> salt concentration <u>and</u> temperature. 1

(ii) Temperature too high (when tide is out) 1

(iii) Salt concentration falls below 2% / too low. 1

(b) (i) Y marked at any point upriver from 7 mm below highest tide mark.
(*i.e. reading up from 1.5% on graph*) 1

(ii) Avoids <u>competition</u> for food/ resources / occupy different niches. 1

(c) Humidity/ amount of water / water level / depth of water;
Oxygen concentration;
Pressure;
Light (intensity) / turbidity;
Current/ wave action/airflow/ wind. max2

(d) More energy initially;
so more steps possible before it „runs out";
or, most animals in rivers / estuaries are ectotherms;
less energy loss between steps. max2

[9]

55. (a) 19.8%/20%; 1

(b) (i) large amounts lost by leaching/denitrification/ammonia release/
input from fixation/food insufficient for needs of plants/animals/ 1

(ii) decrease, because nitrogen fixation by bacteria makes more available; 1

(iii) nitrate/phosphate enters into the surrounding rivers /ponds;
possible eutrophication/ excessive plant growth/algal blooms;
high phosphate causing blue - green blooms/
high nitrate giving blue - green blooms;
excess plant growth exceeds supply of mineral salts;
death and decay of plants by microorganisms/decay increases BOD;
oxygen depletion causes death of fish/fresh water animals; max.4

[7]

56. (a) (i) Carbon dioxide lower when plants photosynthesising (during day/light); 1

(ii) At point B no/little light reaches forest floor;
Little photosynthesis on forest floor/respiration occurring;

(accept converse for point A) 2

(b) Forest has wider range of vegetation types/heights/diversity of plants;
Different/more niches/habitats/food types available for
animals/use of pesticides; 2

[5]

57. (a) (i) Lepus; 1

(ii) Lagomorpha; 1

(b) (i) Distribution / habitat overlaps / found in the same place; 1

(ii) Geographical isolation / separation / barrier;
Adapted to slightly different conditions / environment / different selection pressure;
Mutation in one population / different mutations; max 2

[5]

58. (a) Allow two marks for 617;
allow one mark if arithmetical error in calculation; 2

(b) (i) Moose numbers rose in absence of predators / with plenty of food;
depletion of food / spread of disease / climatic change / resulted in fall / death; 2

(ii) Caused the moose numbers to stabilise at lower level / equivalent; 1

[5]

59. (a) Mark for principle of placing quadrats at random;
marks for detail -
(method of) marking area out with grid/using tapes;
acceptable *method* of generating random numbers; e.g. table/calculator; 3

(b) Any one correct change;
reason for diversity level;
explanation of how heather affects diversity; 3

(c) (i) Award two marks for 0.5 g m^{-2} yr^{-1};;
award one mark for answer without units
or 2.4 – 2.5 %; 2

(ii) Used for non photosynthesising/supporting organs;
eaten by grouse; 2

(iii) Younger plants have more shoots/provide more food;
Younger plants provide more cover;
Getting rid of old (unproductive) plants; max. 2

(d) (i) proteins/nucleic acids/amino acids/ATP/nucleotides;

(ii) ammonium/nitrate/nitrite;

NH_4^+ NO_3^- NO_2^- [Formula must correspond if given] 1

(e) Organic material/proteins to ammonia/ammonium compounds; 1
by saprobiotic/putrefying bacteria;
ammonia to nitrite;
nitrite to nitrate;
by nitrifying bacteria/named bacteria; max. 4

(f) In older stands, greater proportion of/more nitrogen in plants;
more lost when burnt: 2

[20]

60. (a) (i) All (living) organisms/populations found in an ecosystem/in a habitat/in an area; (**NOT** just „all species present"/"no. of spp.") 1

(ii) Habitat (/environment) + community (/described)/
abiotic and biotic factors in a defined area/named area; 1

(b) (i) 9 – 25°C 1

(ii) biotic factor: food/predators/presence of mate/competition/ disease;

abiotic factor: water current/tides/nature of substratum/O_2 (conc) / pH/toxins/light; 2

[5]

61. (a) (i) All the organisms present in an area / all populations in an area / populations of all species in an area / in an ecosystem;
NOT "all the species in an area"

(ii) Habitat + community / environment + organisms / all biotic and abiotic factors of an area; 2

(b) (i) EITHER: More light;
More photosynthesis / fewer spp. adapted to lower light;
OR: Warmer;
Faster metabolism / named aspect; 2 max

(ii) „It" / south-facing is less hostile environment / conditions better / favourable for plants;
Has higher (index of) diversity / more species present;
Provides more niches / described / more complex interactions between species;
Changes in abiotic factors / named example have less influence;
Loss of one species will have less effect on food web / on the system; 3 max

(iii) Greater variety of habitats / described – e.g. re. nesting sites /

humidity / temperature / more food / more variety of food types / less competition for food / more niches; 1

(c) (i) EITHER: Correct answer: 280 (2 marks) ;;
OR: Correct use of data but wrong answer/ P = (40 x 42) ÷ 6 / correct formula (1 mark) ; 2 max

(ii) Sample too small / too few traps / too short a time to mix evenly;
Uneven distribution of animals / great variation trap to trap;
Birth / death of some woodlice;
Immigration / emigration;
Marking method affected woodlouse behaviour; 2 max

[12]

62. (a) (i) B – higher standard deviation; (*extras CANCEL*) 1

(ii) 1st : A (*no mark*)

2nd : Limpets have smaller H/W / smaller mean;
Limpets have (relatively) large foot area;
Better grip on rock; 3

(b) (i) Need representative / „typical" / „reliable" / „valid" value / anomalies less significant / chance variations less significant;
Random sampling overcomes bias / independent of observer;
Ignore „fair"/ „accurate" 2

(ii) Use of quadrat / nearest limpet to… ;
Grid / described – e.g. tape measures / walk to random coordinates;
Method of obtaining random coordinates – tables / calculator; 3

(c) *Any six from:*

Yellow / green OR approx. 500-600mm
1. Penetrates water better;
2. Absorbed by phycoerythrin ;
3. Red seaweeds have phycoerythrin;
4. Red seaweeds photosynthesise in deep water;

Blue AND red OR approx. 460 and 670mm
5. Penetrate water poorly;
6. Absorbed by chlorophyll;
7. Green have only chlorophyll;
8. Green seaweeds can't photosynthesise in deep water

9. Red seaweeds have less competition from green in deeper water / converse in shallow water; 6 max

[15]

63. (a) (i) *Any **four** from*:
1 Several/> 1 traps in each of the two habitats;
2 Place traps at random;
3 Details of method of achieving random layout/random coordinates generated e.g. tables/calculators; [*Reject: "throwing"*]
4 Named factor held constant – e.g. same size traps/same length of time/ same time of day;
5 Count number of insects of each kind/type/species/count number of kinds/ types/species present;
6 Calculate index of diversity (for forest and for field);
e.g. $\frac{d = N(N-1)}{\Sigma n(m-1)}$ = 1 mk + key to symbols = 2 mks max 4

(ii) Any **four** from:
In forest: Greater diversity of insects;
Greater number of plant species/higher diversity of plants;
Greater number/variety of (ecological) niches/habitats;
Greater variety of food;
Less competition for resources/more food available;
Less harsh environment (abiotic) in forest; max 4
[*Accept: converse for cultivated field*]

(b) (i) Any **two** from:
Harvesting/crops are removed;
Less material available for decomposition;
Nitrates/ammonium/soluble compounds/ions leached;
Low initial N-content due to burning; max 2

(ii) Any **five** from:

1 Nitrogen (gas) converted to NOx/nitrates;
2 By lightning/atmospheric nitrogen fixation;
3 Nitrogen (gas) converted to ammonia/ammonium compounds/amino acids;
4 By nitrogen-fixing bacteria;
5 Organic material/leaves from plants (fall onto soil)/animal droppings/dead animals;
6 Broken down by saprotrophs/decomposition;
7 Release of ammonia/ammonium ions (from organic matter/from decay);
8 Ammonia/ammonium converted to nitrite;
9 Nitrite converted to nitrate;

[*Accept: Ammonium → nitrate for 1 mark*]

10 By nitrifying bacteria/correct named example; max 5

[*Note: Formulae, if used on their own, must be correct*]

[15]

64. (a) Samples collected at random;
Method for choosing random sites – random coordinates/position from tables/calculator/other suitable means;

Other named factor constant e.g.:

Same size of net/same width of opening of net/use of one quadrat/ Quadrats of sma size/of stated size/same area disturbed/collect each Sample for same time; 3

(b) *Caenidae* in deep water – because highest standard deviation/ „S.D.= 7.92" 1

(c) (i) An organism"s role/ in the ecosystem/ community;
[ALLOW refs. To trophic levels/named]
(IGNORE refs. To habitat) 1

(ii) *Caenidae* found mainly in deep water AND *Baetidae* in shallow water /one family mainly in deep water AND the other in shallow water; 1

(iii) Reduces competition;
For named factor – e.g. food/shelter/O_2 ;
To ensure both types survive/otherwise better adapted type displaces other type;
OR
Ref. to „Competitive exclusion principle" = 2 marks max 2

[8]

65. (a) Pyramid correctly drawn and trophic levels labelled; 1
Must be in proportion, and labelled using:
Phytoplankton / Zooplankton / Herring OR
Producer / Primary Consumer / Secondary Consumer OR
Candidate's own 'key'

(b) Idea of rapid reproduction to replace population/standing crop / so they don't become extinct;
Idea of supplying energy/biomass to zooplankton;
Idea of taking account of energy losses between trophic levels; max 2

[3]

66. (a) Removal of forest removes many ecological niches/habitats/food sources/shelter;
Reduces numbers of species that can exist in the area; 2

(b) (i) Reduce amount of CO_2 used in photosynthesis;
increase amount of CO_2 produced in combustion/decomposition;

(ii) Less respiration;
By plants/animals/decomposers; max 3

[5]

67. (a) Population – organisms of one species in an ecosystem/habitat/area;
Community – organisms of all species / all populations in an ecosystem/habitat/ area; 2

(b) (i) No immigration/migration (Ignore references to emigration);
No reproduction *(Ignore references to death)*;
Idea of mixing;
Marking does not influence behaviour / increase vulnerability to predation;
Sample/population large enough; max 2

(ii) $\frac{96 \times 77}{11}$; 672; 2
Correct answer (however derived) scores 2 marks
Incorrect answer with evidence of correct method scores 1 mark.

(c) Principle of randomly placed quadrats;
Method of producing random quadrats; *(Reject ‚throwing')*
Valid method of obtaining no. dandelions in given area (mean per quadrat/ total no. in many quadrats);
Multiply to give estimate for total field area; max 3

(d) (i) Niche of A – 1;
Niche of B – 3;
Too small for B / too hot for A – 4;
Too large for A / too cold for B – 2; 2
All four correct = 2 marks; any 2 correct = 1 mark

(ii) Original population living in one area / 2 species evolved in the area;
Idea of genetic variability;
Concept of reproductive isolation;
Possible mechanism;
Gene pools become increasingly different;
Until interbreeding does not produce fertile offspring; max 4

[15]

68. (a) collect a sample (of insects in each area) and mark unobtrusively/in a way not harmful to insects;
release and allow time <u>to re-integrate</u> with rest of population/eq.;
collect second sample and count number marked;
number in population estimated by:

$$\frac{S1 \times S2}{\text{Number marked in } 2^{nd} \text{ sample}} \; / \; / \; \frac{\text{Total marked}}{\text{Number marked in } 2^{nd} \text{ sample}} = \frac{\text{Population}}{\text{second sample}};$$ 4

(b) (i) 1; 1

(ii) (p =) 0.05/ 5%; 1
(ignore 95%)

(iii) value for χ^2 <u>exceeds</u> critical value/ 125.8 > 10.8 ;
Results unlikely to be due to chance/ have a biological cause;
P <0.1% / < 5% ; 2 max

(c) (i) biomass respired/ GPP – respiration = NPP;
biomass lost as CO_2; 2

(ii) more food for insects; 1

(iii) decomposers/ saprotrophs;
release enzymes and digest detritus/
substances found in detritus/ eq.;
absorb products of digestion/ suitable e.g. that relates to candidates 2nd point;
respired and CO_2 released;
used by plants in photosynthesis/ enters leaves; 4 max

[15]

69. (i) Population is the total number of organisms/individuals of a species/tigers in an area (at a given time); 1

(ii) (Deforestation involves) habitat destruction/ destruction of niches;
Some prey animals move out or die / fewer suitable prey for tiger/ less food for tiger; Reduces tiger population if prey biomass falls below 600 (tonnes per km^2); 3

[4]

70. (a) Increase in number of species;
Increase in numbers of some species; 2

(b) Initial environment hostile / few organisms adapted;
These organisms change the environment / suitable example;
More niches / more habitats;
Allowing other organisms to become established; max. 3

[5]

71. (a) (i) ecosystem is (self-supporting) system in which all organisms / community interact with physical environment / community + environment / biotic + abiotic; 1

(ii) A + B + E + F + G + I; 1

(b) pygmy weed competes for CO_2 / light / nutrients; reduction in numbers of original plants;
some of original plant <u>species</u> lost;
loss of habitats / niches / shelter / food sources;
consumers die / some migrate; 3 max

[5]

72. (a) (i) pyramid correctly drawn and labelled;
ignore organic matter 1

(ii) energy lost/not transferred <u>between trophic levels</u>;
in respiration /as heat / in excretory products / movement;
ignore in urea / in faeces. „Growth" cancels 2nd marking point only 2

(b) (i) decomposers convert (nitrogen in organic compounds) into ammonia/ammonium;
suitable example of "organic nitrogen" - protein/urea/amino acid etc. (e.g. linked to process);
nitrifying bacteria / correctly named convert ammonium to nitrate;
via nitrite; 3 max

(ii) convert nitrogen (gas) into ammonium / ammonia / amino acids;
add usable/available nitrogen to an ecosystem / eq.; 2

(c) (i) 1. numbers of dispersed bacteria increase as they <u>feed</u> on organic matter;
2. numbers of free-swimming protoctistans increase because number of bacteria increase;
3. dispersed bacteria decease as amount of dispersed organic matter decreases / due to lack of food / as organic matter is converted to flocs;
4. decrease as are preyed on by free-swimming protoctistans;
5. decrease in free-swimming protoctistans due to lack of dispersed bacteria; 3 max

(ii) 1. (in a succession) organisms (enter an area and) change the environment/conditions;
2. creating new niches / habitats;
3. allows different species / different types of organisms to enter / be successful;
4. dispersed bacteria change dispersed organic matter to floes;
5. presence of flocs allows crawling protoctistans to enter / to increase / to be successful; 4 max

[15]

73. (a) (variation in) temperature will affect the solubility of oxygen/ rate of respiration / use of oxygen by cells/ diffusion/ gas exchange; 1
to gain credit point made must concern oxygen

(b) (i) there is no difference between the partial pressure of oxygen in the two groups / the partial pressure of oxygen is the same in each group; 1

(ii) results may have been due to chance;
statistical test allows us to determine the probability of this / of the difference between results being significant;
enables acceptance or rejection of null hypothesis; 2 max
The key points here are chance and probability used in the correct context.

(c) **A**;
because partial pressure of oxygen only reduced when zinc in water / in **Y** / because when injected zinc / in **X** has no effect on partial pressure of oxygen in blood; 2

(d) less oxygen transport to cells / in fish / in blood;
anaerobic respiration;
lactic acid produced / less carbon dioxide removed (from gills);
more H^+; 3 max

(e) (i) copper;
calculation based on comparing concentration in woodlice with that in leaves; 2
accept any suitable method here, giving marks for the method and explanation. For example, calculating ratio of concentration in woodlice to concentration in leaves.

(ii) not absorbed from gut / passes out in faeces/ egested / urine / excreted; 1

(iii) woodlice eat large amount of leaves;
copper stored/accumulates in body; 2

(f) (i) mutation; 1

(ii) (as a component of) nucleic acids / DNA / RNA / nucleotides;
phospholipids;
ATP/ADP; 2 max

(iii) arsenic-tolerant plants would not be able to take up phosphates / take up a little phosphate;
since likely to involve same mechanism/same carrier/protein;
(process of) growth would be poorer than non-tolerant plants; 3

[20]

74. (a) J and/or K have matured / become adult;
competition / dominance;
J and/or K have established their own territories;
resulting in smaller / changed territories for E and/or H 4

(b) defence of food source / reduces competition for food;
to provide sufficient food for developing young / more young survive
OR
escape routes known;
less chance of predation
OR
place for courtship / nesting;
offspring more likely to be produced
OR
individuals more widely separated;
less likely to contact disease max 2

[6]

75. (a) same intensity/duration of kicking / net held at same depth/distance from bank; 1

(b) hoglice, shrimp, mayfly larvae; 1

(c) sewage contains urea/protein/nitrogen-containing waste;
decomposed by/action of bacteria/saprophytes; 2
(*do not allow nitrifying bacteria, detritivores*)

(d) levels of food/organic material/urea decrease;
fewer microbes/bacteria/saprophytes;
(*do not allow no bacteria*)
less oxygen used in respiration/decomposition/lower BOD;
aquatic plants photosynthesise releasing oxygen; 3 max
(*do not allow splashing introduces oxygen*)

[7]

76. (a) (i) loss of food/habitat/shelter reduces numbers of invertebrates;
and so less food for carnivorous invertebrates/effect further down the food chain described;

(ii) fewer habitats;
limited range of food sources;
unstable ecosystem; 4

(give habitat mark once only)

(b) colonisation by pioneer plants/colonisation by herbaceous plants/change in herbaceous community already present;
colonisation by woody plants;
reference to succession/climax community in correct context;
specified change in the animal community;
specified change in the soil structure/composition; 4

[8]

77. (a) (i) Community;

(ii) Niche;

(iii) Interspecific competition;

(iv) Migration, (*reject - immigration / emigration*) 4

(b) Change over time in species (in the habitat / community);
Change in conditions allowing new species to colonise; 2

[6]

78. (a) Phosphate, because growth increased when phosphate added;
detail explaining limiting factors, e.g. no increase when others added; 2

(b) (i) Sewage / slurry / organic effluent;
Fertiliser;
Detergents; max 2

(ii) Algal / plant growth;
death of algae / plants;
decomposition by microorganisms;
which deplete oxygen; max 3

[7]

79. (a) *Maximum of two marks for two explanations:*
e.g. higher demand for food for humans, so more land used for farming;
increasing demand for linited resources, so less for other organisms. 2

(b) *Maximum of 4 marks, two for named practices and two for explanations of effects:*

e.g. crops are planted (not native plants);
these compete with native plants;

ploughing returns to bare soil;
destroys herbaceous plants/tree/shrub seedlings;

grazing by farm animals;
destroys herbaceous/shrub seedlings/communities. max 4

(c) (i) succession interrupted, so loss of insects/habitat;
many inverts depend on colonising plant species;
these destroyed by farming;
crops deliberated planted by farmers;
these plants mot suitable for insects;
insects nowhere to lay eggs/no food for young;
many of these insects seen as pests;
pesticides used by farmers destroy insects. max 3

(ii) a lot of species on dead trees endangered cf live trees;
there are fewer dead trees (than previously);
reason for dead trees being removed;

a lot of beetles on dead trees endangered cf live trees;
dead trees a habitat for more species, so more affected;
by loss of dead trees;

butterflies do not feed on dead trees;
so not affected. max 3

[12]

80. (a) fungus:
makes minerals available from breakdown of rock/bark absorption from the atmosphere;
provides alga with protection from environment/drying out
provides anchorage to rocks; any 1

alga:
photosynthesis /description of photosynthesis, provides fungus with sugars/nutrient/carbohydrate; 1

(b) lichens able to survive hostile environment;
(death of lichens/ growth of) lichens/other named plant makes the habitat less hostile;
example of reduce hostility;
(trap soil particles/ absorb water/ add humus)
other plants move into the changed environment;
slow growth limits spread of lichens/
other plants grow faster/spread over habitat; 4

[6]

81. (a) *reasonable attachment method*(*s*)*:*
e.g. roots able to penetrate mortar;
suckers;
tendrils;
xerophytic adaptation(*s*)*:*
e.g. leaves able to resist desiccation;
small leaves to reduce area for evaporation;
succulent stem/leaves;
reasonable growth habits:
e.g. stems grow outwards then upwards; 2

(b) (i) e.g. more light on south side/warmer on south side 1

(ii) control variables: similar soil, similar temperatures;
independent variable – one batch grown in high light intensity, one batch in low light intensity;
dependent variable –size of plants/leaves after reasonable interval
OR
large number sampling sites – north and south-facing walls;
light intensity measured at each site;
light intensity measured at each site; 3

[6]

82. (a) light intensity measured at each site;
temperature;
light intensity;
oxygen;
minerals/nutrients;
carbon dioxide;
pH 3 max

(b) L. trisulca produces fewer „leaves"/does not grow as well when L. minor present as when alone;
L. minor produces more „leaves"/grows better when L. trisulca present than when alone 2

(c) L. minor grows on surface therefore receives more light than L. trisulca;
therefore more photosynthesis by L. Minor
OR
substances released by L. trisulca;
promote growth of L. Minor 2

[7]

83. (a) (i) climax 1

(ii) scheme carried by moving water trapped;
humus/underground stems/roots stablise soil;
on death, add humus/peat/litter/matter
(*BUT NOT minerals nutrients*) 2 max

(iii) active uptake of ions requires energy;
from (aerobic) respiration;
since against concentration gradient 3

(b) more niches greater <u>variety</u> of habitats/breeding sites;
greater <u>variety</u> of food
more stable;
less hostile/more favourable conditions/example 2 max

[8]

84. (a) no <u>significant</u> difference in X/<u>significant</u> difference in both Y <u>and</u> Z *gains 1 mark*
BUT <u>significant increase in Y AND significant decrease in Z</u> *gains 2 marks*;
computed values of $\mathbf{X}^2$ for Y and Z <u>greater</u> than
table value at 0.05 level at 1 d.o.f;
(*allow computed values > 3.84 / probability of computed values < 0.05*) 3

(b) (winter grazing) only one to show a <u>significant</u> increase (over the 7 years) 1

(c) more eggs laid (on each vetch plant) when grass kept short;
grazing keeps grass short;
no increase in butter flies (when sheep graze) in summer since will eat vetch with eggs on 3

[7]

85. (a) Succession;
Foxgloves change conditions to allow other species to move in;
Growth of shrubs / small trees;
Outcompete/more successful than foxgloves for named resource; 3 max

(b) (i) Long period for growth/photosynthesis/more leaves/early start in second year;
More food reserves for seed production; 2

(ii) Not many will reach suitable conditions/clearings are rare/ better chance of some reaching a clearing;
Small so more easily/more widely/wind dispersed; 2

(c) Slows conduction from SAN/ to AVN;
Slows down contraction of ventricles/heartbeat/heart rate/rhythm of heartbeat disrupted;
Less blood/oxygen pumped around the body/to tissues;
Effect on behaviour, e.g. mammals that eat them deterred or become less active;
Selection favours those that do not eat foxgloves; 3 max

[10]

86. dry/lack of water/saline / doesn't hold water / water drains through;
plus 2 of:
reduced rate of transpiration / evaporation / diffusion;
reduced SA;
decrease in water potential gradient / humid air trapped/ reducing diffusion / air movement / increase diffusion pathway; 3 max

[3]

87. (a) have coexisted for several years;
reds disappeared before the greys arrived;
reds in coniferous woodland,greys in broad-leaved woodland/ different niches / different diet; 2 max

(b) red squirrel doesn't secrete/produce the enzymes required to hydrolyse/ breakdown/digest acorns;
unable to absorb the products of digestion;
toxins in the acorns to which they have no resistance;
inability to break open acorn/starch grains;
acorns lack vital/named nutrient / nutrient needed by red squirrels;
energy to digest acorns greater than energy obtained from digested acorns; 2 max

(c) limited supply of food / competition for food;
greys better competitors; 2

[6]

88. (i) idea of rise and fall;
peak and trough later than those of larvae/idea of time lag;
(*allow correct line drawn on the graph*) 2

(ii) reduction in leaf area/size decreases photosynthesis;
less food reserves available for production of new needles;
OR
feeding larvae damage more growing points;
takes time for tree to recover/ less growing time for needles; 2

[4]

89. (a) (i) tips colonised by short-lived plants / short lived plants are pioneers;
short-lived plants fast growing/spreading/distribute seeds quickly;
short-lived plants change the environment e.g. make conditions more favourable for long-lived plants;
valid reference to competition;

(ii) long-lived plants compete with each other;
death of some long-lived plants;
more niches / leaving spaces/areas for growth of short-lived plants;
short-lived plants recolonise; 6 max

(b) control of named variable e.g. light, water-content, nutrients;
large numbers of both species/10+ individuals;
range of different concentrations of zinc;
valid measurement of growth, height/leaf area/root growth/numbers/mass/ % germination;
statistical analysis/correlation between the two sets of data;
OR
large number of samples taken (in the field);
principle of determining zinc concentration of soil;
valid measurement of growth, height/leaf area/root growth/numbers/mass/% germination;
statistical analysis/correlation between the two sets of data; 3 max

[9]
QWC 1

90. (a) description of interspecific competition/competition between species/ birds with beaks of different lengths;
link length of beaks to different positions of prey/reference to named bird with particular prey e.g. curlews with longer beaks able to feed on ragworms; 2

(b) variation in beak length in curlews/one species;
longer/more curved beaked curlews outcompete/ at advantage;
suggested advantage e.g. larger/curled beaks access more food;
reproduction;
genes passed on (to offspring); 4 max

(c) body has lower water potential;
water diffuses along a water potential gradient/by osmosis; 2

[8]

91. (a) pioneers/suitable example colonise land;
example of change in environment;
enables change in species;
conditions change further/example to favour trees; 4

(b) stable community/no further succession/final community; 1

(c) roots unable to respire (aerobically);
active transport of minerals/other metabolic effect stops; 2

(d) action of bacteria/decomposers inhibited/ fewer bacteria/decomposers;
acid conditions inhibits enzymes/enzymes denatured/changes active site;
H^+ ions affect active site;
anaerobic conditions; 3 max

[10]

92. (a) proteins/amino acids broken down;
deamination/ammonification/ release of ammonium compounds;
conversion to nitrates;
by nitrifying bacteria/named bacterium;
nitrates absorbed into roots; 5

(b) fewer nitrates in the soil for the next crop/plants grow less well
because of lack of nitrates;
requiring application of more fertiliser;
economic reason for using less fertiliser;
valid environmental reason explained e.g. nitrates leaching into
water/eutrophication/explanation/health related e.g drinking water; 2 max

(c) production of phospholipids;
in cell membranes;
synthesis of ATP;
production of DNA;
production of RNA;
production of NADP; 4 max

[11]

93. (a) (i) dogwhelks move more; 1

(ii) their food contains more material that cannot be digested /
no enzymes to digest;
such as cell walls/cellulose; 2

(b) TBT is accumulated;
dogwhelks eat many mussels; 2

[5]

94. (a) 1. colonisation/pioneering;
2. microscopic plants at start;
3. death / decomposition;
4. named change in environment e.g. increase in organic matter/ stabilisation;
5. new species colonise once there is a change;
6. increase in number of species/diversity;
7. increase in total amount of living material/biomass/ more niches;
8. increase in nutrient availability;
9. change from more extreme conditions / more stability; 6 max

(b) marking principles:
one mark – direct result of removing forest cover;
e.g. soil erosion/leaching
one mark – specific effect on organisms in lake;
e.g. more sediment/nutrients (for plants to grow) 2

(c) 1. named nutrient availability;
2. numbers of producers providing energy (for a food chain);
3. light intensity affecting the rate of photosynthesis;
4. disease killing (weaker) members of species;
5. space for nest building / niches;
6. reproductive rate balancing death rate;
7. competition for a named limited resource;
8. (intra and interspecific) competition explained;
9. predation described; 5 max

[13]

95. (a) not biodegradable/ not broken down by enzymes/ deposited in tissues;
taken up by producers and thus passed up food chains;
accumulated in tissues of organisms at each (trophic) level; 2

(b) with hormone (third column) cadmium produces large/ significant/45% fall in enzyme production;
without hormone (second column) no significant effect on enzyme production with cadmium;. 2 max

[4]

96. (a) (i) true indication of growth / water mass may vary; 1

(ii) intraspecific; 1

(iii) the denser the planting the greater the yield;
above a planting density of approx 30 competition for named resource / named limiting factor/ population density not limiting; 2

(accept nutrients/space reject food)

(b) use genetically identical plants / clones/ asexual reproduction/ tissue culture;
maintain identical environmental conditions/named condition;
reference to density of planting; 2 max

[6]

97. (a) species present change the habitat/named change;
other species able to colonise;
new species better competitors; 3 max

(b) D - as more species present;
more complex food webs;
change in one species will have little effect on others;
as alternative food sources; 2 max

(c) sand drains easily/low water retention;
(sunken stomata) reduce transpiration;
as pocket pf saturated air trapped near stomatal pore;
this reduces diffusion/water potential gradient; 3 max

(d) series of changes over a distance;
gradient of environmental factor/named environmental factor/cline present;
ensures sampling of each community; 1 max

[9]

98. (a) zooplankton nearer surface at night;
algae only found at surface;
photosynthetic;
no/little light below 30/40m; 3

(b) (i) with increasing time predators have been present in the lake, the greater the depth at which the zooplankton occur during the day; 1

(ii) variation in migration behaviour;
vertical migration reduces chance of predation/prey can't be seen in low light intensity;
those that migrated more likely to reproduce;
genes/alleles (for behaviour) passed to next generation;
increase in frequency of gene/allele in population; 3 max

[7]

99. (a)
1. shore crab rapidly colonises/rapid growth;
2. ability to live different environments;
3. no natural predators;
4. will have similar/overlapping niche with native species/ valid example;
5. shore crab better competitor/more aggressive;
6. decreased population of prey species;
7. other food implications/change in species diversity;
8. ecosystem less stable;
9. shore crab may be carrier of disease; 5 max

(b) between A and B water potential of blood rises as water potential of blood rises as water potential of surrounding water rises, after B rise in water potential less rapid/at C no further change occurs; 1

(c) No – as blood is isotonic with surrounding water/blood and surrounding water have same water potential; 1

(d) (i) water potential of blood maintained;
so (blood) cells not destroyed (by osmosis);

OR

replaces ions/salts lost diffusion;
ions/salts required for named metabolic process; 2

(ii) rate of respiration decreases;
less ATP made;
insufficient to maintain water potential of blood when in estuary;
isotonic in sea so no need to transport salts;

OR

sea temperature higher than river;
higher metabolic rate/higher enzyme activity;
advantage of this crab e.g. still able to escape from predators; 3 max

[12]

100. (a) principle of intraspecific competition;
for amount of food available;
more energy needed to find food/less energy to produce eggs;

OR

number of territories;
more energy spent fighting/defending territory;

OR

availability as prey;
predators spend less time searching for nests; 2 max

(b) (i) age of bird - young or old birds produce fewer eggs;
time of breeding - early or late breeding less food available/

temperature effect;
genotype - variation in genetic ability to produce eggs;
quality of territory - description of some relevant resource in territory;
(reject food as resource in territory if given in(a))
predation of eggs - lays more to replace eaten eggs; 1 max

(ii) when high number of eggs, each individual young will receive less food; reference to mortality rates to disease/predators for low numbers of eggs; so in both cases low number of offspring will reach maturity/survive; so less likely to pass on genes/alleles; 3

[6]

101. (a) (i) change in community over time;
either due to change environmental/abiotic factors / change is due to species present; 2

(ii) stable community/no further succession/final community; 1

(b) (increased) interspecific competition;
for light/nutrients/named nutrient/water; 2

(c) fewer leaves/lower surface area/shading of leaves;
less photosynthesis to produce new biomass/glucose/growth;
competition with other species for nitrates/named nutrient;
reduced synthesis of protein or named compound;
ratio of leaves to woody parts and roots decreases;
so higher respiration relative to photosynthesis; 3 max

[8]

102. (a) 1. 4 year cycles;
2. predator/stoat peaks after prey/lemming;
3. lemmings increase due to low numbers of stoats/available food;
4. more food for stoats so numbers increase;
5. increased predation reduces number of lemmings;
6. number of stoats decreases due to lack of food/starvation; 6

(b) smaller populations have fewer different alleles/more homozygosity/less heterozygosity/smaller gene pool/lower genetic variability;
migrants bring in new alleles/increase gene pool; 2

(c) geographical isolation of populations;
variation present in population(s);
different environmental conditions;
different selection pressures/different phenotypes selected;
change in genetic constitution of populations/gene pools/allele frequency;
(two populations) so unable (to breed) to produce fertile offspring; 4 max

[12]

103. (a) (i) Two marks for correct answer of 1760 (seals per year)
One mark for incorrect answer showing clear evidence of calculating rate by dividing number by time; 2

Q *Note that working mark cannot be awarded unless method is shown clearly and unambiguously*

(ii) Fewer whales means more krill;
More krill-feeding fish;
More food for seals; 2 max

(b) Data can be collected rapidly;
Does not require defining individual plants; 2

(c) Change in species composition;
Greater area of bare ground;
Lower diversity; 3

Q *Credit should not be given for imprecise answers relating to "plants".*
Final point requires specific reference to diversity

(d) Seals produce nitrogenous waste/urine/faeces;
Produces ammonium ions/nitrates by decomposition/nitrification; 2

[11]

104. (a) 1 Sample of ground beetles captured and counted (a);
2 Released and second sample captured;
3 Count total number of beetles (B) and number marked (b);
4 Total population (A) estimated from the relationship $\frac{a}{A} = \frac{b}{B}$;
5 Detail of method e.g. pitfall trap/marking with tippex;
6 Refinement to ensure greater accuracy e.g. large number/ marking in position such that does not affect survival; 5 max

(b) 1 Mowing prevents growth of woody plants;
2 By cutting off growing point;
3 The longer the interval between mowing, the further succession can progress;
4 With frequent mowing diversity of plants will be less;
5 Fewer insect inhabitants/niches available; 5

Q *Since this is an ecological question, use of appropriate ecological terminology is expected. Credit such terms as producer, consumer, habitat, and niche. Do not credit inappropriate terminology such as "places" to live and "fighting for food".*

(c) 1 Higher carbon dioxide concentration at night/during darkness;
2 Photosynthesis only takes place during light;
3 Photosynthesis removes carbon dioxide and respiration adds carbon dioxide;
4 Respiration taking place throughout 24 hours;
5 Quantitative consideration such as that in plants overall photosynthetic rate greater than respiration rate;
6 Human effect such as additional carbon dioxide from heavy daytime traffic/street lighting could prolong photosynthesis; 5 max

[15]