M1. (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:

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

2

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

1

[5]

M2. (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]

M3. (a) (i) More micronutrients / greater range of nutrients;
Nutrients released slowly;
Improves soil quality / adds humus / adds microbes / improves soil structure;
Improves water-holding capacity of soil / reduces leaching/eutrophication;
Improves soil aeration;
Already available;

max 2

(ii) Known nutrient content;
Nutrients available immediately/fast acting;
Nutrients distributed evenly;
Doesn't contain pests;
Better to handle / easy to use / easy to store/transport;
Concentrated in nutrients / needed in smaller amounts;
Applied using light machinery so avoids soil compaction;

max 2

(b) (i) Same as other plots / named variable controlled;
Without fertiliser;

2

(ii) Contains a nutrient/nutrients important for mangolds /
Idea that different crops have different nutrient requirements /
Inorganic fertiliser contains ingredient which inhibits beet growth;

max 1

[7]

M4. (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]

M5. (a) decomposers/detritus feeders/saprotrophs/saprotrophic bacteria or fungi;

1

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

(allow m^{-3})
(two correct units gains 1 mark
(all three correct gains 2 marks)

2

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

3 max

[6]

M6. (a) (i) mass produced increases then levels off at 17.1 kg m^{-2} / concentrations above 40 kg ha^{-1};

1

(ii) replaces nutrients removed;
fertiliser provides nitrate needed for protein/amino acid production; as more fertiliser added, there is more growth / protein/amino acid / yield;

max 2

(iii) plants already have enough nitrate / nitrate no longer limiting;
another named factor/element is limiting growth;

2

(b) because cattle excreted / produced faeces/droppings/cowpats/ manure; in field B crop used elements/minerals/nitrates/ nutrients last year;

2

(c) (If no comparison made, assume candidate means 'compared with organic')

advantages: easy to handle/apply/transport/store;
known chemical content / can supply specific needs;
easy to control mass that is added / less mass needed;
releases ions/nutrients quickly / soluble;

max 2

disadvantages: expensive / leads to eutrophication / environmently damaging /
uses resources to make it /
does not add to soil structure /
lacks some nutrients;
(Accept converse if clearly identified)

1

[10]

M7. (a) greenflies take in (small mass of) insecticide from roses/leaves;
ladybirds eat large numbers of/more/many greenflies;
bioaccumulation idea / insecticide cannot be excreted/remains in body/stored in fat/not broken down;

3

(b) (i) chemical: numbers fluctuate throughout year;
biological: numbers fairly constant throughout year /
accurate description;

2

(ii) number of plants drops because of spraying/reapplication, then
rises because insecticide washed away/new plants grow;

1

(c) (i) chemical: some plants/parts of plants are not
sprayed / spray washes off before it has effect;
plant may be resistant to spray;
(Reject 'immune')

2

(ii) biological: because biological control never eats all plants;
as weeds diminish so do control agents and/or *vice versa* /
is balance between food and consumer;

2

[10]

M8. (a) contain nitrogen-fixing bacteria in roots/nodules (so don't need fertiliser);
nitrogen containing compounds added to the soil
when plant dies/after harvest of crop;

2

(b) increase in yield up to 500-600 kg ha^{-1};
at 500-600 kg ha^{-1} rate of increase slows/ no significant increase
(with extra fertiliser);

2

(c) low(er)/more negative water potential in soil (than in the plant);
prevents roots from taking up water (from the soil);
plants still lose water by transpiration; plants lose water to soil
by osmosis;

2 max

[6]

M9. (a) 1. High temperature allows enzymes to work faster/allows more
collisions/ allows more e-s complexes to be formed

OR

A lot of light so light not limiting;

2. Photosynthesis reactions are faster/more photosynthesis;

1. Accept enzymes more effective. Ignore references to respiration. Ignore references to optimum (temperature or light).

2

(b) (i) Gross productivity = net productivity + respiratory loss/respiration;

Accept any correct rearrangement of this equation

Accept recognisable abbreviations

Reject respiratory rate.

1

(ii) 1. Respiration slower / less respiration;

2. Light-dependent reaction/photosynthesis less affected by temperature increase;

3. Lower (energy) loss;

1. Unspecified references refer to August. Allow converse of respiration faster but must specify July / higher temperature

3. Unspecified references refer to August. Allow converse of higher loss but must specify July

"Lower respiratory losses (in August)" can meet both points 1 and 3 and gain 2 marks.

2 max

(c) 1. Stored as fat/glycogen/biomass;

2. Used for growth/movement/reproduction / process involved in growth/movement/reproduction;

1. Reject stored energy. Ignore respiration

2 max

(d) 1. More heat/energy is lost (in March)/colder (in March);

2. Maintain/regulate body temperature/more heat generated;

3. By respiration/metabolism;

2. Accept keep warm.

2 max

[8]

M10. (a) (accumulates) in (fatty) tissue/ is not excreted/ not metabolised/broken down;
becomes concentrated higher up the food chain/ bioaccumulation/ biomagnification;

2

(b) prevents disease/pest organisms from reaching crop plants/prevents herbicides from reaching hedgerow/enables machinery to manoeuvre without damaging crop/hedgerow;

1

(c) some weeds provide habitats/niche for (beneficial) insects/animals:
allow (insect) pest predators to survive;
conserve (common) weed plants;
weeds are producers in food chains/food source;

2 max

(d) decomposers/saprophyte/ bacteria/ fungi /micro organisms;
(organisms) excrete/ produce nitrogenous waste/ e.g.;
bacteria convert to nitrate/nitrifying bacteria;
(increased) nitrates(in soil) taken up/used by plants;
release of phosphate/potassium;
organisms respire and produce carbon dioxide;
used by plants in photosynthesis;

4 max

[9]

M11. (a) (i) 1. Gases / correct named gas not released;

2. Conditions (in digester) can be controlled;

3. Products/named product can be collected;

4. Open ponds associated with health risk/environmental damage/eutrophication;

Correct named gases include: methane, carbon dioxide, hydrogen sulphide, nitrogen oxides

1. Allow substance = product

4. Accept 'pond' in any context

2 max

(ii) 1. Respiration causes temperature increase/release of heat;

2. Enzymes would be denatured/microorganisms killed;

2

(b) (i) 1. Increase algae/algal bloom;

2. Light blocked out;

3. Plants can't photosynthesise / plants and/or algae die;

4. Bacteria/saprobionts/EW feed off/breakdown dead organisms;

5. Bacteria/saprobionts/EW use up oxygen/bacteria respire/BOD rises;

On its own, the word eutrophication does not gain a mark, the stages need to be described.

EW = equivalent word

3 max

(ii) 1. Acts as soil conditioner/improves drainage/ aerates soil/increases organic content of soil;

2. Contains other elements/named element/wider range of elements;

3. Production of artificial fertiliser energy-consuming;

4. Less leaching / slow release (of nutrient);

Unspecified answers relate to natural fertiliser. Ignore references to cost / eutrophication

2. i.e. elements other than nitrogen, phosphorus and potassium

1 max

[8]

M12. (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]

M13. (a) Pyramid correctly drawn and trophic levels labelled;
Must be in proportion, and labelled using:
Phytoplankton / Zooplankton / Herring OR
Producer / Primary Consumer / Secondary Consumer OR
Candidate's own 'key'

1

(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]

M14. (a) light is wrong colour/frequency/wavelength/does not strike chlorophyll molecule/chloroplasts/there is another limiting factor;

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

1

(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]

M15. (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 decrease 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 flocs;

5 presence of flocs allows crawling protoctistans to enter / to increase / to be successful;

4 max

[15]

M16. (a) (variation in) temperature will affect the solubility of oxygen/ rate of respiration / use of oxygen by cells/ diffusion/ gas exchange;
to gain credit point made must concern oxygen

1

(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;
The key points here are chance and probability used in the correct context.

2 max

(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;
accept any suitable method here, giving marks for the method and explanation. For example, calculating ratio of concentration in woodlice to concentration in leaves.

2

(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]

M17. (a) No competition/weaker competitor in US;
No organisms to eat it/pathogens to infect it in US;
Environment/abiotic factors more favourable/specific example e.g. temperature/water availability;
More reproduction;

max 2

(b) (Yes because) reduces;
Stays low;
OR
(No because) reduces;
But does not get rid of plants completely;

2

(c) (i) Number of fire-ants falls rapidly/most killed;
Population remains low;

2

(ii) Most fire-ants killed;
(Some survive because) some resistant;
Insecticide does not affect all stages of life cycle/named stage;
Insecticide does not reach all individuals/example
e.g. underneath leaf;
Survivors reproduce;
Because of reduced competition/greater availability of food;

max 3

(d) 1 Specific (to one pest);

2 Only needs one application/reproduces;
allow long lasting effect

3 Keeps population low;

4 (Pests) do not develop resistance;

5 Does not leave chemical residues in environment; not just environmentally friendly

6 Does not get rid of pest completely;

7 May become a pest itself;

8 Slow acting/takes time to reduce pest population;

9 Can be used in organic farming;

max 6

[15]

M18. (a) (i) Reduced cost;

Less feed/less land use/more growth rate with same amount of food;

Allow is 'cost effective'

2

(ii) Amount of food taken in less than expected.

Allow 'expected food intake is higher,

Allow 'food intake is lower than it should be'

1

(b) Type of food (not a mark)

1. May vary in protein/fat/carbohydrate/fibre/roughage/ vitamins/minerals;

2. May affect absorption/digestibility/energy value/tastiness/ growth/overall food intake;

For mark point 1 allow appropriately named food compound e.g. cellulose, glucose

For mark point 2 it must be clear that these factors are affected by the type of food.

Temperature (not a mark)

3. Will affect heat loss/gain/respiration/metabolism;

4. (Need) to maintain/regulate body temperature;

5. More food/energy can be used for growth;

Note: two maximum marks for effect of temperature.

4 max

(c) (i) RFI does not affect methane production/

There is no difference in the rate of methane production for low and high RFI values/

The difference between the rates of methane production is due to chance/

No correlation/relationship/link between RFI and methane production;

Any clear statement that there is no link between RFI and methane production should be credited.

1

(ii) (Cattle with low RFI) produce less methane;
Methane linked to greenhouse effect;

2

(d) (i) Sulfate without straw;

1

(ii) 1. May affect yield/damages rice crop;

2. Substance/treatment may affect other organisms/environment;

3. Cost of substance/application/labour;

4. Method/frequency/timing of application/amount of substance required;

2 max

(iii) Not flooded aerobic conditions/more oxygen/with flooding anaerobic conditions/less oxygen;

Not flooded fewer/less active anaerobic microorganisms/respiration/ not flooded more/more active aerobic microorganisms/respiration;

2

[15]

M19. (a) Extracellular digestion/releases enzymes;

Starch to monosaccharides/glucose/sugars/smaller molecules ;

Respire product of digestion;

Produce carbon dioxide from respiration;

2 max

(b) Correct answer of 40;;

Incorrect answer showing clearly that a difference in mass has been divided by time;

2

(c) Lower as plants contain a lower proportion of nitrogen/higher proportion of carbon/higher C:N ratio;

Nitrogen found (mainly) in protein/amino acids/nitrogen used to make protein;

2

(d) Investigation refers to a single species and other species might not respond in the same way;

Investigation carried out in greenhouse where conditions controlled;

Accept any other valid answers relating to how an increase in carbon dioxide concentration might increase caterpillar damage, e.g.:

Caterpillars may eat more to compensate (for low nitrogen/protein);

Increased temperature (resulting from higher carbon dioxide concentration will increase rate of growth/reduce generation time;

Other organisms interfere with results;

Remember question concerns caterpillar damage

2 max

[8]

M20. (a) 1 Light (energy) excites/raises energy level of electrons in chlorophyll;

2 Electrons pass down electron transfer chain;

Q *Accept any reasonable alternative for electron transfer chain.*

3 (Electrons) reduce carriers/passage involves redox reactions;

4 Electron transfer chain/role of chain associated with chloroplast membranes/in thylakoids/grana;

Example such as chemiosmosis;

5 Energy released/carriers at decreasing energy levels;

6 ATP generated from ADP and phosphate/ P_i/phosphorylation of ATP;

5 max

(b) 1 Some light energy fails to strike/is reflected/not of appropriate wavelength;

2 Efficiency of photosynthesis in plants is low/approximately 2% efficient;

3 Respiratory loss/excretion/faeces/not eaten;

4 Loss as heat;

5 Efficiency of transfer to consumers greater than transfer to producers/approximately 10%;

6 Efficiency lower in older animals/herbivores/primary consumers/ warm blooded animals/homoiotherms;

7 Carnivores use more of their food than herbivores;

Q *Accept figures below 5%. Accept figures over 5% but below 10% if clearly related to maximum efficiency.*

6 max

(c) 1 Slaughtered when still growing/before maturity/while young so more energy transferred to biomass/tissue/production;

2 Fed on concentrate/controlled diet/controlled conditions/so higher proportion of (digested) food absorbed/lower proportion lost in faeces/valid reason for addition;

3 Movement restricted so less respiratory loss/less energy used;

4 Kept inside/heating/shelter/confined so less heat loss/no predators;

5 Genetically selected for high productivity;

Q *The principle here is one mark for identifying a relevant point and offering an explanation. Accept other equivalent answers.*

4 max

[15]