QUESTIONSHEET 1

(a) hydrogen peroxide; **1**

(b) (i) to release catalase from within liver cells; **1**

(ii) Any 2 of: same weight of liver/same species/animal for liver/same volume of buffer at same pH/keep cool or at 4^0C /homogenise in blender for same time;; **2**

(c) vary temperature of water bath/incubator;
10^0C intervals over suitable range (eg. 0 – 70^0C);
same standard homogenate of liver in each case;
measure volume of oxygen produced in a standard time/in 1 minute;
repeat experiment at each temperature and calculate means;
allow acclimatisation time at each temperature before adding peroxide; **max 5**

(d) Any two of: volume of oxygen is affected by changes in temperature/pressure/
concentration of catalase in different liver extracts may vary/
some oxygen may be retained in conical flask by frothing;; **2**

TOTAL 11

QUESTIONSHEET 2

(a) amylase;
reject 'pancreatic amylase' **1**

(b) (i) acts as cofactor/allosteric effector;
binds to the enzyme changing its molecular shape;
so that the active site becomes operative/can bind with substrate; **max 2**

(ii) pH too low/acid;
enzyme is denatured; **2**

(c) Enzyme = maltose;
Juice = intestinal/succus entericus;
Product = glucose; **3**

TOTAL 8

QUESTIONSHEET 3

(a) (i) substrate concentration is the limiting factor;
some active sites free;
(thus) increase in substrate concentration can increase rate; **3**

(ii) number of active sites is limiting factor/all available active sites occupied with substrate;
number of substrate molecules exceed number of active sites;
(thus) increase in substrate concentration cannot increase rate; **3**

(b) enzymes have an optimum pH (at which they work at maximum rate);
pH changes from optimum cause changes in shape/charges/ionisation state of active site;
therefore reduces number of enzyme-substrate complexes;
(and thus) reduce the rate; **4**

TOTAL 10

QUESTIONSHEET 4

(a) a specific series of linked reactions;
each step of which is catalysed by a specific enzyme;
named example/glycolysis/Krebs/any other example; **max 2**

(b) removes CO_2 from (carboxylic) acid group/decarboxylation; **1**

(c) modifies/changes enzyme so that it can function/acts as a cofactor; (reject 'gives energy') **1**

(d) once a certain amount of adrenaline/nor-adrenalin has been produced;
nor-adrenaline inhibits conversion of tyrosine to dopa/feedback inhibition/end product inhibition; **2**

(e) adrenal medulla/sympathetic nerve synapses; **1**

TOTAL 7

QUESTIONSHEET 5

(a) substance/chemical which is structurally similar to normal substrate;
and competes with it for active site of enzyme; **2**

(b) number of substrate molecules exceeds number of molecules of inhibitor/substrate molecules occupy most /many of the active sites;
therefore little inhibition/inhibition reversed by high substrate concentration; **2**

(c) competitive inhibitors (CIs) structurally similar to substrate, non-competitive inhibitors(NCIs) not similar;
CIs bind to active site, NCIs bind elsewhere on enzyme;
effect of NCI is permanent/cannot be reversed by increasing substrate concentration whereas Cl effect is temporary/can be reversed by high substrate concentration; **3**

TOTAL 7

QUESTIONSHEET 6

(a) (i) X is a protease/peptidase/splits peptide bonds/hydrolyses peptide bonds;
causes inactive enzyme precursor to change shape/conformation;
produces active/catalytic form/exposes active sites; **3**

(ii) precursor fits into complementary active site of enzyme X;
credit reference to specificity; **2**

(iii) metabolic control/control of reaction rates/prevent cell lysis/protection of gut wall; **1**

(b) either: pepsinogen; HCl;
or: trypsinogen; enterokinase;
(accept any correct example) **max 2**

TOTAL 8

QUESTIONSHEET 7

(a) raise temperature of water in waterbath to 65°C (checking with thermometer);
maintain by adding hot water/thermostatic control;
keep sucrase and sucrose in separate tubes until both solutions are 65°C/equilibrate for at least 5 minutes;
add sucrase to sucrose and mix gently; **4**

(b) forms a brick-red precipitate with reducing sugars/glucose/fructose;
sucrose is a non-reducing sugar/does not react with Benedicts reagent;
but if sucrose is digested (by sucrase) will give a positive Benedicts test; **max 2**

(c) (i) reaction fastest at 40°C;
because higher kinetic energy/more collisions between enzyme and substrate/ref to optimum temperature/
enzyme substrate complexes formed quicker; **2**

(ii) initial colour change may indicate early enzyme activity;
but kinetic energy/molecular excitation/high temperature;
caused denaturation/disruption of active site/breakage of hydrogen bonds/disulphide bridges/loss of tertiary structure;
3

TOTAL 11

QUESTIONSHEET 8

(a) Any four of:
use equal masses of each tissue/
ground up equally/same time and speed of grinding/
equipment washed between samples/
equal volumes of hydrogen peroxide used/
tissues completely immersed/
effervescence measured at same time interval;;;; **4**

(b) (i) liver; **1**

(ii) most metabolically active/highest or fastest respiratory rate; **1**

(c) more enzyme = more active sites;
more collisions between substrate and active site/faster formation of enzyme-substrate complexes; **2**

TOTAL 8

QUESTIONSHEET 9

(a) changes shape of active site; **1**

(b) (i) decreases/stops it; **1**

(ii) substrate no longer able to bind to active site so that enzyme-substrate complex cannot form;
allosteric inhibitor attaches to enzyme at a site other than the active site;
but changes the molecular shape of the enzyme; **max 2**

(c) Y;
normal substrate of glucose phosphorylase is glucose;
Y is similar shape/structure; **3**

TOTAL 7

QUESTIONSHEET 10

(a) (i) B: pepsin works in stomach/acid environment;
alkaline solution would disrupt charges on/shape of active sites/tertiary structure/might denature enzyme; **2**

(ii) C+D: boiling denatures enzyme;
active site/tertiary structure lost; **2**

(iii) E: no enzyme present; **1**

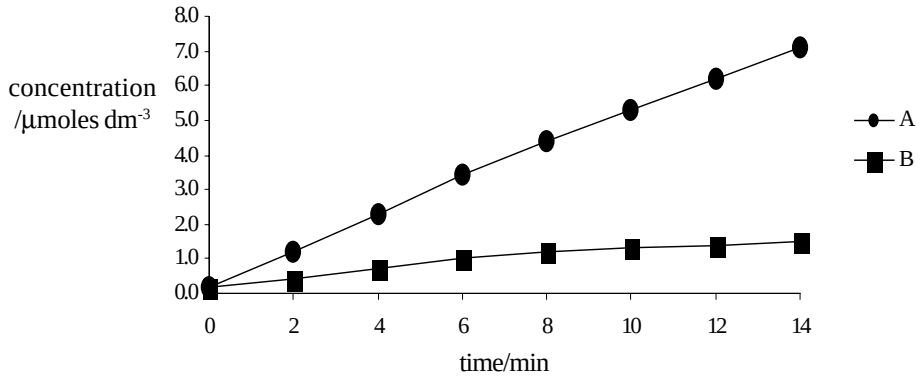
(b) add more egg white to tube A/repeat experiment in tube A; **1**

(c) to show that boiling inactivated the enzyme in both pH's; **1**

TOTAL 7

QUESTIONSHEET 11

(a)



time on X axis and concentration on Y axis with units;
suitable scale which is easy to use (at least ½ the graph paper sheet);
accurate clear plotting;
points joined cleanly using a ruler (according to Institute of Biology Guidelines for A level Biology);
(lines of best fit/curves will not be accepted by Examining Boards in this type of question)
curves labelled clearly/suitable key; **5**

(b) readings from graph at 11 and 3 minutes are 5.75 and 1.75

$$\frac{5.75 - 1.75}{8} = ;$$ 0.50 micromoles dm^{-3} min^{-1}; **2**
(correct no of significant figures needed.
units needed.
allow consequential errors and range $\pm$ 0.05.)

(c) (i) A, because the rate of substrate digestion was the highest overall; **1**

(ii) temperature;
use a water bath/incubator;
pH;
use a buffer; **4**

(d) Any two of:
tenderising of meat/
predigesting baby foods/
rennet in cheese manufacture/biological washing powders/making leather pliable/dissolving blood clots
/lowering protein content of flour for biscuit manufacture/brewing;;. **2**

TOTAL 14

QUESTIONSHEET 12

(a) (i) C;
(ii) D;
(iii) B;
(iv) A; **4**

(b) malonic acid/malic acid;
inhibits succinic dehydrogenase; **2**

TOTAL 6

QUESTIONSHEET 13

Feature	Amylase	Lactic dehydrogenase
Will breakdown lactose	×	× ;
Found only in animals	×	× ;
Requires NAD	×	✓ ;
Is a Hydrolase	✓	× ;
Can be made by GE	✓	✓ ;
Can be used to make yoghurt	×	× ;

(Lactobacilli used to make yoghurt) **TOTAL 6**

QUESTIONSHEET 14

(a) 43% ; **1**

(b) (i) pancreas; **1**

(ii) to provide the correct pH for the enzyme/may be a enzyme cofactor; **1**

(c) amylase in seed hydrolyses starch to reducing sugars/maltose;
to act as respiratory substrate to provide energy for germination;
amylase will only operate efficiently near optimum temperature/increase in temperature increases amylase activity; **3**

(d) heat energy disrupts hydrogen bonds holding 3-D structure (of protein) together;
ref denaturation; **2**

TOTAL 8

QUESTIONSHEET 15

ATP/adenosine triphosphate;
glycosidic;
hydrolases;
water;
oxido-reductases;
NAD/FAD;
NADP;
activation energy; **TOTAL 8**

QUESTIONSHEET 16

(a) plant cell wall/middle lamella (of cell wall) contains pectin/calcium pectate/magnesium pectate;
this is degraded/broken down by pectinase;
thus releasing cell contents/juice/oils/pigments from fruit;
fewer bits of fruit/cell wall left suspended (in juice); **max 3**

(b) use same mass of apple tissue in each sample;
tissue from same apples/batch of apples/variety of apples;
at same stage of ripeness;
homogenise (in blender/food mixer) for a standard time/speed;
one sample with pectinase solution added and one sample with an equivalent volume of water added;
allow to stand for a suitable time/at least 30 minutes/to enable enzyme to work;
both samples at same temperature/room temperature/37^{o}C in water bath/incubator;
filter/low power centrifugation in a standard way/for a standard time;
measure volume of juices collected;
compare clarity by eye/measure turbidity with photometer;
do replications; **max 8**

TOTAL 11

QUESTIONSHEET 17

(a) pH/hydrogen ion concentration influences the ionisation of R-groups/side chain groups;
which influence the conformation/shape of the protein/enzyme/active sites;
so that active site can join to the substrate/ref induced fit hypothesis/lock and key hypothesis;
best fit/most efficient enzyme action occurs at optimum pH/around pH 2.2;
shape of active site less suitable at pHs either side of the optimum so that rate of activity falls;
pH may also affect ionisation of substrate which could influence rate of reaction;
ref to <u>extremes</u> of pH cause denaturation; **max 5**

(b) shape of active site must adjust slightly to accommodate different shapes/ionic states of albumin and haemoglobin;
slight changes in pH will slightly alter active site shape/ionisation;
thus trypsin is able to digest more than one type of protein;
ref to induced fit hypothesis/mechanism; **max 3**

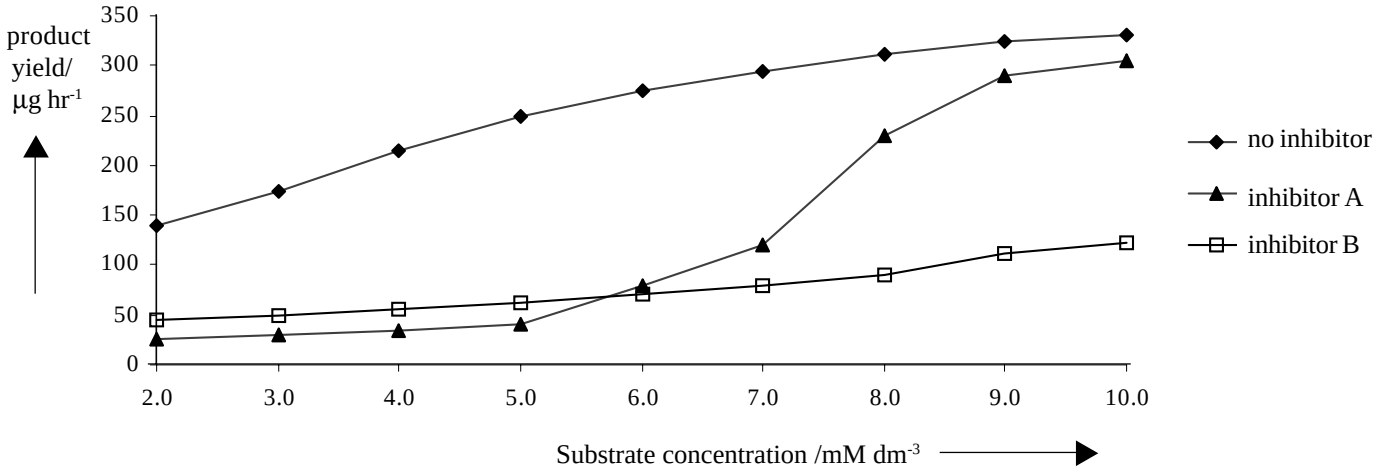
(c) acetylcholine esterase is important in regulating nervous/synaptic transmission;
operates efficiently over a wide pH range/pH 6.9 – 10, so not affected by body pH changes in this range;
also operates reasonably effectively from pH 6.0 – 6.9/in dilute acidic conditions; **max 2**

(d) operates effectively over a wide range of pH values whereas pepsin would only be effective in low pH range/high acidity;
pH 2 would affect flavour of meat/make it unpalatable/papain could be used at pH 7 which would not affect the meat flavour;
2

TOTAL 12

QUESTIONSHEET 18

(a)(i)



axes correct and labelled;
suitable scale;
accurate plotting;
points joined with a ruler (IOB recommendations)
curves labelled/suitable key; **5**

(ii) same concentration of enzyme in each;
above limiting concentration;
same volumes for each reagent;
suitable pH maintained by a buffer;
suitable temperature/37°C maintained by waterbath;
same incubation time for each; **max 4**

(b) 1. competitive;
because when substrate concentration is in excess/rises above inhibitor concentration/above 5.0 mM dm^{-3};
product yield rises to a high level; **3**

2. non-competitive;
because yield of product remains low;
even when substrate concentration is high/in excess of inhibitor; **3**

(c) succinic dehydrogenase; succinic acid; fumaric acid; malonic/malic acid; **4**
(accept any other correct example)

TOTAL 19

QUESTIONSHEET 19

(a) enzymes are attached to/entrapped by insoluble materials/matrix which gives support to the enzyme;
enzyme is then held in place during the reaction;
whole cells/yeasts/bacteria with specific enzymes can also be immobilised; **3**

(b) product will not be contaminated by the enzyme;
since enzyme cannot escape from the matrix;

enzyme can be recovered and used again many times;
useful if enzyme is costly/hard to extract/produce;

enzyme is more stable at extremes of temperature/pH;
since protected by the matrix;

very useful for continuous fermentations;
since enzymes/cells remain trapped in matrix;

immobilised whole cells mean that enzyme sequences/several enzymes can operate simultaneously;
reducing number of steps in the process/reducing cost; (any three pairs of marks) **max 6**

(c) use of glucose isomerase to convert glucose to fructose (when making fructose syrups);
continuous production of ethanol using yeast/zymase;
production of vinegar using Acetobacter; **max 2**

TOTAL 11

QUESTIONSHEET 20

(a) hundreds of enzymes in cell must work in relationship together/in integrated fashion;
some will need to work quicker/slower than others so that products are formed in an orderly way/at correct rate/at a rate that does not cause inbalance;
having different pH-activity profiles/different optimum pHs means that they are not all working at peak rate;
thus intracellular pH has a controlling influence on (intracellular) enzyme actions; **max 2**

(b) carbonic anhydrase has a large number of active sites per molecule whereas succinic dehydrogenase only has one or a few;
carbonic anhydrase has high activity to convert all carbon dioxide to carbonic acid/hydrogen carbonate ions in red cells (and converse reaction);
must have reserve capacity so that (blood) CO_2 tension does not build up during strenuous activity;
succinic dehydrogenase limited by capacity of mitochondrion to absorb pyruvate,
so will not need a very high turnover number; **max 2**

TOTAL 4