PHOTOSYNTHESIS

ANSWERS & MARK SCHEMES

QUESTIONSHEET 1

(a) A - vascular bundle;
B - palisade mesophyll;
C - spongy mesophyll; **3**

(b) B/palisade mesophyll; **1**

(c) (i) 1 = double membrane/envelope; 2 = granum; 3 = quantosomes;
4 = stroma; 5 = lipid droplet; 6 = starch grain; **6**

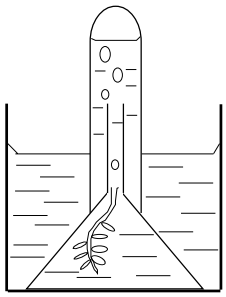
(ii) 1. dark/Calvin/light independent reaction;
2. light/Hill/light dependent reaction; **2**

TOTAL 12

QUESTIONSHEET 2

(a) light intensity; **1**

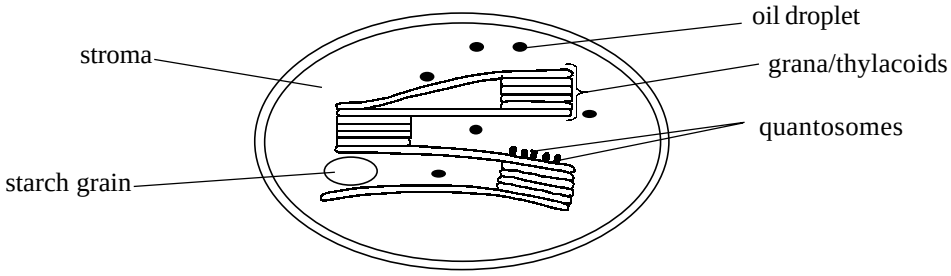
(b) Y - some other factor is limiting reaction;
Z - light intensity is no longer limiting the reaction;
probably carbon dioxide concentation is now limiting; **3**

(c) 

correct arrangement of beaker, funnel and test tube;
plant in correct position with end in stem of funnel;
water and oxygen bubbles correctly shown; **3**

TOTAL 7

QUESTIONSHEET 3

(a) 

(i) stack of grana/thylakoid/quantosome should be labelled; **1**
(ii) stroma should be labelled; **1**
(iii) starch grain/oil droplet should be labelled; **1**

(b) glycerate phosphate/phosphoglyceric acid/PGA; **1**

(c) chlorophyll a;
chlorophyll b;
carotene;
phaeophytin/xanthophyll; **max 3**

TOTAL 7

QUESTIONSHEET 4

(a) A = 15 mmol CO_2 m^{-2} sec^{-1}; (allow 15.1)
B = 25 mmol CO_2 m^{-2} sec^{-1}; (allow only 1 mark if no units) **2**

(b) B; because it photosynthesises faster than A up to 20 ^{0}C/photosynthetic rate decreases/ lower than A after 20^{o}C; **2**

(c) because the enzymes are denatured/description of denaturation;(No mark for saying "killed".) **1**

(d) Any two of: light intensity/carbon dioxide tension/lack of water;; (not just 'light/CO_2/water') **2**

TOTAL 7

QUESTIONSHEET 5

(a) correct labelled axes (distance on X-axis);
suitable scale (at least half the graph paper);
accurate plotting;
points joined with a ruler (according to IOB instructions for A-Level Biology);
curves labelled; **5**

(b) (i) from 2 to 0.5m, the rate of photosynthesis increases;
after this increasing the light intensity has no effect on the photosynthetic rate;
CO_2 tension probably limiting; **3**

(ii) lower rate of photosynthesis overall in A;
limiting effect in A starts at lower light intensity;
lower rate of photosynthesis in A when CO_2 is limiting; **3**

(c) $I_A = \frac{1}{0.75^2}$; = 1.778 ; (accept 1.78) $I_B = \frac{1}{0.50^2}$; = 4.0; **4**

TOTAL 15

QUESTIONSHEET 6

(a) A - carbon dioxide;
B - ADP;
C - NADP; (B and C could be the other way round) **3**

(b) stroma; **1**

(c) can be used to regenerate RuBP; **1**

(d) from the quantosomes/thylacoid membranes;
products of light dependent reaction/photophosphorylation; **2**

(e) polymerisation/condensation/removal of water;
joining glucose molecules by alpha-glycosidic links; **2**

TOTAL 9

PHOTOSYNTHESIS

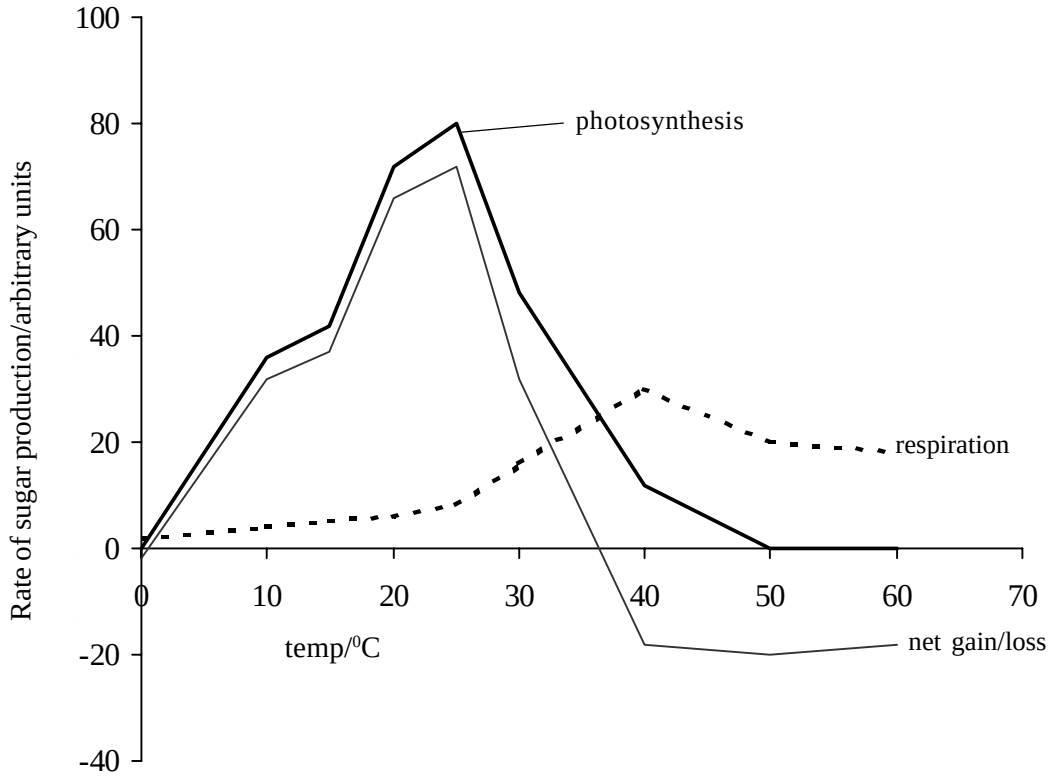
ANSWERS & MARK SCHEMES

QUESTIONSHEET 7

(a) (i)

Temp ^{0}C	Net loss/gain
0	-2
10	32
15	37
20	66
25	72
30	32
40	-18
50	-20
60	-18

;; (2 marks if all correct, penalty of 1 mark per error) **2**



(ii) axes labelled (temp. as X axis); suitable scale; accuracy of plotting; points joined with a ruler; curves labelled; **5**

(b) (i) 25^{o}C;
(ii) 40^{o}C; **2**

(c) (i) the light intensity;
at which the rates of photosynthesis and respiration are the same; **2**

(ii) 36.5^{o}C; (accept 36.0 to 37.0) **1**

TOTAL 12

QUESTIONSHEET 8

(a) oxygen is an inhibitor of photosynthesis at higher concentrations;
little or no inhibition at atmospheric concentrations;
oxygen is a competitive inhibitor of RuBP carboxylase; **3**

(b) atmospheric levels of carbon dioxide are sub-optimal for photosynthesis;
rates of photosynthesis can be increased by increasing atmospheric concentration of carbon dioxide;
especially at high light intensity;
reference to principle of limiting factors; **4**

(c) (i) the light intensity;
at which the rates of photosynthesis and respiration are equal/no net gain or loss in weight; **2**

(ii) photosynthesis exceeds respiration;
thus plant gains sugar for storage; **2**

(iii) dim light in wood;
thus compensation point occurs at a low light intensity so plant starts to accumulate sugar sooner; **2**

TOTAL 13

QUESTIONSHEET 9

(a) (i) absorption spectrum shows amount of light absorbed (by photosynthetic pigments) at different wavelengths;
action spectrum shows rate of photosynthesis at different wavelengths;
both have similar profiles/peaks in red and blue; **3**

(ii) cyclic involves photosystem 1 and non-cyclic involves both photosystems 1 and 2;
cyclic generates ATP and non-cyclic generates ATP and NADPH;
non-cyclic is coupled to photolysis of water but cyclic is independent of this; **3**

(iii) C_3 plants produce glyceraldehyde 3 phosphate (3C) from ribulose bisphosphate and CO_2;
C_4 plants produce malic acid (4C) from phospho-enol pyruvic acid and CO_2;
C_4 plants more efficient in high O_2 tensions; **3**

(b) (i) magnesium ions are a component of chlorophyll;
bound onto porphyrin ring of chlorophyll; **2**

(ii) large subunits on thylacoids house photosystem II;
small subunits on thylacoids house photosystem I; **2**

TOTAL 13

QUESTIONSHEET 10

(a) (i) to ensure no starch is present in the plant at the beginning of the experiment;
as this is what is being tested for; **2**

(ii) starch is broken down to sucrose/glucose;
and used for respiration/transported to roots/storage organ; **2**

(b) dip leaf in boiling water to kill cells;
place in boiling alcohol to remove chlorophyll;
wash in hot water to soften;
spread on a white tile and flood with iodine in potassium iodide;
blue/black indicates presence of starch; **5**

(c) A is completely blue black, B is only blue black where there was no cover;
covered part of B remains iodine colour;
thus starch only made in areas exposed to light; **3**

TOTAL 12

QUESTIONSHEET 11

(a) X- chloroplast;
Y- mitochondrion;
A- oxygen;
B- carbon dioxide; **4**

(b) oxidative phosphorylation uses energy from oxidation;
of reduced coenzymes/NADH;
to produce ATP;
photophosphorylation involves using light energy;
to produce ATP;
and reduced NADP/NADPH; **6**

(c) (i) ATP used as energy supply for CO_2 fixation in the dark/Calvin reaction;
NADPH used as reducing power when CO_2 is converted to carbohydrate in dark/Calvin reaction; **2**

(ii) ATP is needed for many synthetic chemical reactions;
and processes such as active transport; **2**

TOTAL 14

QUESTIONSHEET 12

(a) carotene; red; blue; electron carriers; ATP; stroma; hydrogen; water; NADPH; Calvin; phosphoglyceric; ribulose bisphosphate; hydroxide; oxygen; **14**

(b) water absorbed by roots is a reactant/supplies electrons/H;
for uptake/transport of minerals/needed for turgidity; **2**

TOTAL 16

QUESTIONSHEET 13

(a) more light at top of tree than at bottom which is shaded;
thus more chloroplasts needed at top and so more palisade cells/fewer chloroplasts needed in shade
/comment on adaptation to microclimates;
possibly lower leaves cannot make enough food to enable growth of extra cells/lower leaves have less nutrition; **3**

(b) peas and beans contain Rhizobium/root nodules for nitrogen fixation;
thus can make more protein; **2**

(c) waste carbon dioxide produced by power station is bubbled through lake;
assimilated by Chlorella for growth and reproduction;
Chlorella is harvested for use as cattle food/reduces CO_2 emission and greenhouse effect; **3**

TOTAL 8

QUESTIONSHEET 14

(a) (i) stomatal width increases as concentration of starch decreases; **1**

(ii) stomatal width decreases as concentration of starch increases; **1**

(b) (i) light stimulates conversion of starch to sugars;
therefore as light intensity increases, starch decreases;
sugars reduce water potential of guard cells;
water enters osmotically;
as guard cells swell, stomatal pore opens;
ref uneven thickening of guard cell walls; **max 4**

(ii) closed/reduced aperture;
deficit of water means guard cells cannot absorb any and so cannot swell; **2**

(c) peel off epidermis/make a varnish imprint;
use low power light microscope and eyepiece micrometer;
count number of stomata in a square mm; **3**

TOTAL 11

QUESTIONSHEET 15

(a) most bacteria in red light and blue light/400-450 nm and 650-700 nm/few in yellow-green areas/equivalent; **1**

(b) bacteria congregate where oxygen concentration is greatest;
oxygen released in photosynthesis;
these are the most effective (wavelengths) in photosynthesis; **3**

(c) each pigment absorbs different wavelengths/parts of visible spectrum/has different absorption maxima;
accessory pigments/carotene/xanthophyll become excited/energised;
and pass excited electrons onto chlorophylls;
therefore leaves/plants are able to absorb more/a lot of light; **max 3**

TOTAL 7

QUESTIONSHEET 16

(a) compensation point;
light intensity at which CO_2 uptake = CO_2 output/rate of photosynthesis equals rate of respiration;
plant can only gain mass/grow when X is exceeded; **max 2**

(b) increasing light intensity stimulates light dependent stage/stimulates cyclic/non-cyclic photophosphorylation;
some other factor becoming limiting/slowing rate of reaction;
such as carbon dioxide concentration; **max 2**

(c) (i) oxygen;
NADPH;
ATP; **3**

(ii) ATP provides energy for conversion of PGA to TP;
NADPH provides hydrogen/H atoms/reducing power for conversion of PGA to TP; **2**

TOTAL 9

QUESTIONSHEET 17

(a) $\frac{190 + 180 + 185}{3}$; = 185 mg CO_2 $6hr^{-1}$; **2**

(b) Y;
CO_2 absorbed in light;
plus CO_2 released in respiration (in light); (Reject respiration in dark -it is not photosynthesising in the dark) **3**

(c) $\frac{180}{200}$ x 100 ; = 90% ; **2**

(d) Chlorella absorbs CO_2 to make biomass;
this can be sold as cattle fodder/food/fertiliser;

Chlorella absorbs CO_2 and so reduces greenhouse effect;
reduces global warming/eq. ; **4**

TOTAL 11

QUESTIONSHEET 18

(a) (i) amino acid/protein/DNA/RNA/nucleotide synthesis; **1**

(ii) carries energy in form of ATP/ref. to photophosphorylation; **1**

(iii) component of chlorophyll molecules/component of middle lamella (of cell wall); **1**

(b) factor which limits/restricts the rate of a process/named metabolic process;
that factor which is closest to its minimum value; **2**

(c) (i) higher phosphate increases yield; **1**

(ii) 60 (59-61) kg ha^{-1}; **1**

(d) (i) leaching out into water contributing to eutrophication/blue baby syndrome/may increase risk of stomach cancer if converted to nitrosamines; **1**

TOTAL 8

QUESTIONSHEET 19

(a) cut up leaves and macerate/grind up;
suitable solvent/acetone/acetone ether mixture;
micropipette on to paper repeatedly;
allow to dry each time/use of hair dryer; **4**

(b) Any two of: use pencil line, not ink/pen/
do not allow solvent to touch line/
seal/allow time to achieve saturated atmosphere in tube/
do not allow paper to touch sides/avoid contamination by substances on fingers/
keep cold/in dark;; **2**

(c) different pigments absorb different wavelengths/parts of visible spectrum;
greater amount of light absorbed/faster photosynthesis; **2**

TOTAL 8

QUESTIONSHEET 20

(a) ensure pigment spot is above solvent/ensure atmosphere in container was saturated with solvent before running; **1**

(b) solutes/pigments dissolve in solvent;
solvent moves up paper;
distance moved by solutes/pigments depends on their relative solubility/molecular size; **2**

(c) (i) relative flow (Rf) is a physical constant;
for a specific solute in a specific solvent;
it is the distance moved by the solute divided by the distance moved by the solvent (front); **max 2**

(ii) B = $\frac{35}{93}$ = 0.38; (0.376) C = $\frac{36}{93}$ = 0.39; (0.387) **2**

(ii) 2-way chromatography/run with a different solvent; **1**

TOTAL 8