Past-paper walk-through

Photosynthesis as an energy transfer process ▪ 13.1

eXercise

Questions in this set

- 9700/41 N25 Q3 ▪ 13 marks
- 9700/44 N25 Q10 ▪ 7 marks
- 9700/41 J25 Q4 ▪ 14 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 3

9700/41 N25 ▪ Q3 ▪ 13 marks

3 Plants have several different photosynthetic pigments in their chloroplasts.

(a) A student separated and identified the chloroplast pigments present in a leaf extract from a spinach plant using two slightly different methods.

Method **A**

- A type of chromatography known as thin layer chromatography (TLC) was used to separate the pigments.
- A mixture of ether and cyclohexane was used as a solvent in TLC.

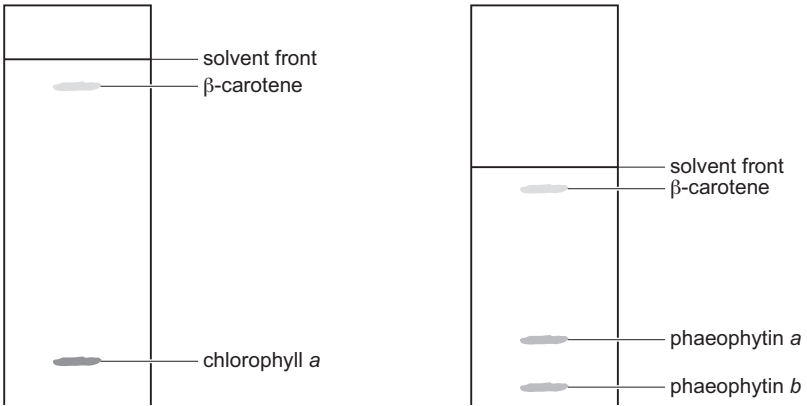
Method **B**

- The student repeated TLC but treated the spinach leaf extract with a chemical. The chemical causes a magnesium ion in a pigment to be replaced by two hydrogen ions.
- The student used a leaf from the same spinach plant, and used the same solvent as in method **A**.

The student calculated R_f values and compared these to reference values to identify the pigments.

Question 3

Fig. 3.1 shows the results for method **A** and method **B**.



Question 3

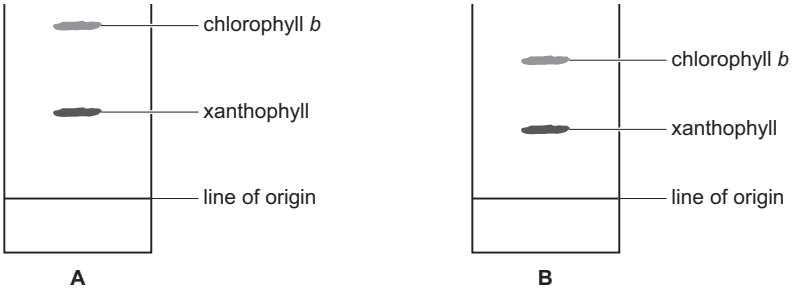


Fig. 3.1

(i) Calculate the R_f value of β-carotene in Fig. 3.1.

Question 3

Question 3

[2]

(ii) Suggest **two** explanations for the differences in appearance of chromatograms **A** and **B** in Fig. 3.1.

Question 3

[2]

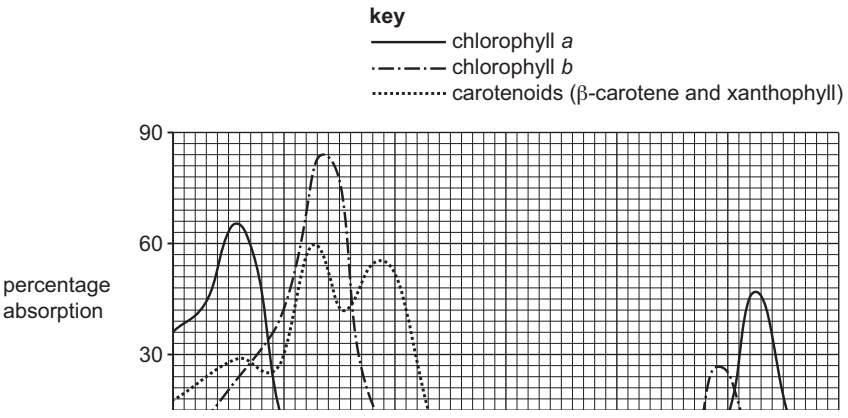
(iii) The student found some different R_f values for the chloroplast pigments of spinach in a scientific paper.

The values in the scientific paper were different from the reference values that the student originally used to identify the pigments on chromatograms **A** and **B** in Fig. 3.1.

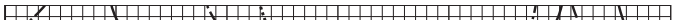
Suggest **one** reason, other than measurement error, for the different R_f values.

Question 3

(b) Fig. 3.2 shows the absorption spectra of some chloroplast pigments.



Question 3



Question 3

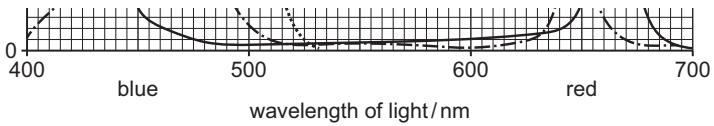


Fig. 3.2

Use Fig. 3.2 to compare the similarities and differences between the absorption spectra of chlorophyll *a* and carotenoids.

Question 3

(c) In some species of plant, the absorption of light stimulates seed germination.

The absorption of light increases the production of gibberellin in the embryo of a seed.

Describe the role of gibberellin in the germination of a seed.

Question 3

[Total: 13]

Solution 3

(a)(i)

Mark scheme

- 0.95 (no units) ; ;
- 2

Solution 3

(a)(ii) Mark scheme

- any two from:
- 1
- B, run for less time / stopped early ;
- 2
- chlorophyll, converted / changed, to phaeophytin ;
- 3
- AVP ;
- 2

Solution 3

(a)(iii) Mark scheme

- any one from:
- 1
- different solvents ;
- 2
- different, TLC plate / chromatogram / stationary phase (material) ;
- 3
- different temperatures ;
- 1

Solution 3

- 9700/41
- October/November 2025

Solution 3

(b) Mark scheme

- any four from:
- similarities
- 1
- both absorb, blue / between 400 and 475 nm ;
- 2
- both absorb, little / no, light between 525 and, 600 / 630, nm
- or
- both absorb, little / no, green / yellow, light ;

Solution 3

- 3
- AVP ;
- max three differences
- 4
- chlorophyll a absorbs, at more / a larger range of, wavelengths ;
- 5
- chlorophyll a absorbs, more / better, between 400 and 445 nm ;
- 6
- carotenoids absorb, more / better, between 445 and 525 nm ;
- 7

Solution 3

- chlorophyll a absorbs between, 600 / 640, and, 680 / 690 nm, and carotenoids do not ;
- 8
- chlorophyll a (blue absorption) peak / highest, at 425 / 430 nm and
- carotenoids (blue absorption) peak / highest, at 460 / 465 nm ;
- 9
- chlorophyll a has blue peak and red peak but
- carotenoids have two blue peaks and no red peak
- or
- chlorophyll a has two peaks but

Solution 3

- carotenoids have three peaks ;
- 4

Solution 3

(c) Mark scheme

- any four from:
- 1
- gibberellin, moves to / acts on / stimulates, aleurone layer ;
- 2
- binds to, (gibberellin) receptor / GID(1) ;
- 3
- breaks down DELLA (protein) ;
- 4

Solution 3

- releases, PIF / transcription factor ;
- 5
- switches on gene for, amylase / maltase / protease ;
- 6
- amylase, breaks down / hydrolyses, starch to maltose ;
- 7
- sugars / glucose, for, respiration / growth, of embryo ;
- 4
- 9700/41
- October/November 2025

Question 10

9700/44 N25 ▪ Q10 ▪ 7 marks

10 (a) Cyclic photophosphorylation and non-cyclic photophosphorylation occur during the light-dependent stage of photosynthesis.

Outline the **differences** between cyclic photophosphorylation and non-cyclic photophosphorylation.

Question 10

(b) Complete the passage about the Calvin cycle using the most appropriate word or words.

Question 10

This reaction produces a six-carbon compound that splits into two molecules of a three-carbon compound, glycerate 3-phosphate (GP).

Question 10

of a three-carbon sugar, triose phosphate (TP).

Question 10

recycled to regenerate RuBP using ATP.

[4]

[Total: 7]

Solution 10

(a) Mark scheme

- any three from:
- cyclic
- non-cyclic
- 1
- photosystem I (only)
- vs
- photosystems I and II
- ;

Solution 10

- 2
- electrons return to, same
- photosystem / PSI / P700
- vs
- electrons do not return to
- same photosystem
- ;
- 3
- ATP made
- vs

Solution 10

- ATP and reduced NADP
- made
- ;
- 4
- no photolysis
- vs
- photolysis
- ;
- 5
- no oxygen produced

Solution 10

- vs
- oxygen produced
- ;
- 3

Solution 10

(b) Mark scheme

- 1
- carbon dioxide ;
- 2
- Rubisco ;
- 3
- NADPH ;
- 4
- glucose / hexose / starch / cellulose /

Solution 10

- glycerol / fatty acids / lipids /
- amino acids / proteins ;
- 4

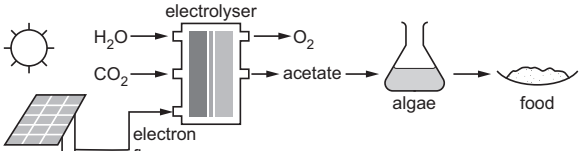
Question 4

9700/41 J25 ▪ Q4 ▪ 14 marks

4 Scientists have invented a way of producing food by artificial photosynthesis.

- Solar panels convert sunlight energy into electricity.
- The electricity powers an electrolysis reaction between carbon dioxide gas and water to form the organic product acetate.
- The single-celled alga *Chlamydomonas*, a protoctist, can use acetate to grow and reproduce in the dark, instead of photosynthesising in the light.
- The algae can be processed to make a food product.

Fig. 4.1 shows an outline of the artificial photosynthesis process.



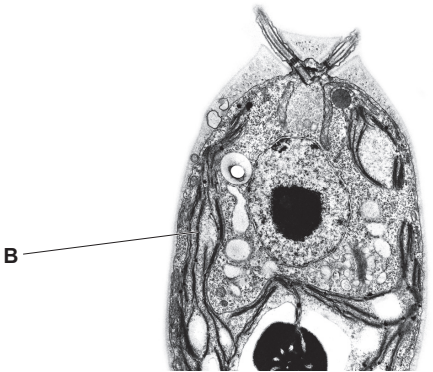
Question 4

Fig. 4.1

(a) Identify **three** similarities between the artificial photosynthesis process shown in Fig. 4.1 and the normal process of photosynthesis.

Question 4

(b) Fig. 4.2 shows the single-celled alga *Chlamydomonas*. It contains a large, cup-shaped chloroplast for photosynthesis.



Question 4

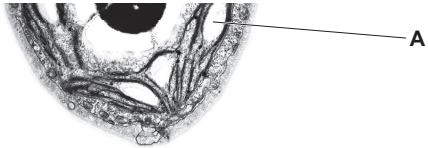


Fig. 4.2

Structures **A** and **B** in Fig. 4.2 are found within the chloroplast.

Name structures **A** and **B**.

Question 4

Question 4

[2]

(c) Thylakoid membranes are the site of the light-dependent stage of photosynthesis.

(i) Name the products of the light-dependent stage of photosynthesis.

Question 4

(ii) Some of the protein components of the thylakoid membrane have a role in the light-dependent stage of photosynthesis.

Explain the roles of the different proteins that function in the light-dependent stage of photosynthesis.

Question 4

(d) The products of the light-dependent stage of photosynthesis are used in the Calvin cycle. Calvin cycle intermediates are used to produce amino acids, carbohydrates and lipids.

Name the Calvin cycle intermediate that can be used to produce starch.

Question 4

(e) Scientists claim that the artificial photosynthesis process shown in Fig. 4.1 is more efficient at converting light energy into food than normal photosynthesis by crop plants.

Give reasons why this claim may or may **not** be true.

Question 4

[3]

[Total: 14]

Solution 4

(a) Mark scheme

- any three from:
- (both processes)
- 1
- use / require, carbon dioxide / CO_2 ;
- 2
- use / require, water / H_2O ;
- 3
- use / require, (sun) light energy / source of energy is light ;

Solution 4

- 4
- make an organic, molecule / product ;
- 5
- produce / release, oxygen / O2 ;
- 6
- involve transduction of energy (from one form to another) ;
- 7
- involve electron flow ;
- 3

Solution 4

(b)

Mark scheme

- A
- starch, grain / granule ;
- B
- thylakoid (membrane) / lamella / granum ;
- 2

Solution 4

(c)(i)

Mark scheme

- ATP and reduced NADP (and oxygen) ;
- 1

Solution 4

(c)(ii) Mark scheme

- any four from:
- 1
- electron carriers / electron transport chain / to carry electrons ;
- 2
- to release energy to, move / pump, protons (into, thylakoid space / lumen)
- or
- to release energy to generate proton gradient ;
- 3

Solution 4

- oxygen-evolving, complex / enzyme ;
- 4
- (to catalyse) splitting / photolysis, of water ;
- 5
- LHC / antenna complex / photosystem, proteins hold pigments ;
- 6
- ATP synth(et)ase to make ATP ;
- 4

Solution 4

(d)

Mark scheme

- triose phosphate ;
- 1
- 9700/41
- May/June 2025

Solution 4

(e) Mark scheme

- any two plus one opposing arguments based on correct ref. to:
- 1
- percentage / amount, of sunlight, absorbed / used ;
- 2
- absorption / action, spectrum
- or
- wavelengths / colours of light, used ;
- 3

Solution 4

- respiration of organism ;
- 4, 5 stage/transition, where, energy lost ; ;
- 6, 7 (named) limiting factor(s) ; ;