



- 4 One way of calculating the rate of respiration is to measure the volume of oxygen taken up over a period of time.

A student carried out an experiment to investigate the effect of temperature on the rate of respiration in soaked (germinating) pea seeds and dry (dormant) pea seeds.

A simple piece of apparatus called a respirometer was used, as shown in Fig. 4.1.

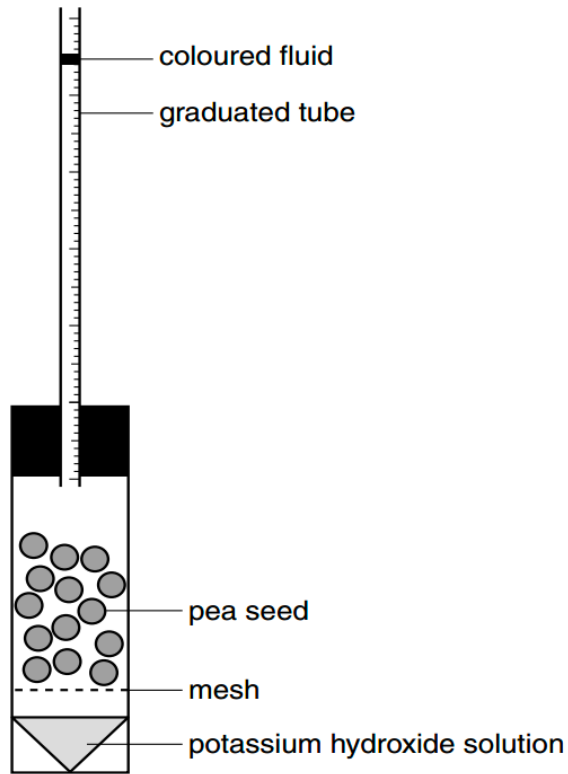


Fig. 4.1

The potassium hydroxide solution in this apparatus absorbs carbon dioxide. If the apparatus is kept at a constant temperature, any changes in the volume of air in the respirometer will be due to oxygen uptake.

(a) State the stage or stages of aerobic respiration during which:

- (i)** carbon dioxide is produced

.....
..... [1]

- (ii)** oxygen is used.

.....
..... [1]



- (c) After the student had left each respirometer to equilibrate, a small volume of coloured fluid was introduced into each graduated tube.

The respirometers were then left in the appropriate water baths for 20 minutes and maintained at the correct temperature. During this time, the coloured fluid in the graduated tube moved.

The level of the coloured fluid in each respirometer was recorded at the start of the experiment and after 20 minutes.

The results are summarised in Table 4.2.

Table 4.2

temperature (°C)	respirometer	reading at start (cm ³)	reading after 20 minutes (cm ³)	difference (cm ³)	corrected difference (cm ³)	rate of oxygen uptake (cm ³ min ⁻¹)
15	A	0.93	0.74	0.19	0.16	0.008
	B	0.93	0.86	0.07	0.04	0.002
	C	0.91	0.88	0.03		
25	A	0.94	0.63	0.31	0.27	
	B	0.93	0.84	0.09	0.05	0.003
	C	0.95	0.91	0.04		

- (i) Table 4.2 is incomplete.

Calculate the missing value for the rate of oxygen uptake for soaked pea seeds (**A**) at **25 °C**.

Show your working.

Answer = cm³ min⁻¹ [2]

(ii) Explain why there is an increased rate of respiration in soaked seeds at 25 °C compared with soaked seeds at 15 °C.

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.....
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..... [2]

(iii) Suggest a reason for the difference in the rate of respiration between soaked and dry pea seeds.

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.....
.....
..... [2]

[Total: 12]



Question			Answer	Marks	Guidance
4	(a)	(i)	link reaction and Krebs cycle ;	1	Mark the first 2 answers. If they are correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks
4	(a)	(ii)	oxidative phosphorylation ;	1	Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks ACCEPT electron transport chain / electron transport system / electron carrier chain IGNORE chemiosmosis DO NOT CREDIT photorespiration
4	(b)	(i)	<p>1 to make the <u>volume</u> of , contents / 'peas' , the same (in the respirometers) ;</p> <p>2 <i>idea that because</i> the <u>volume</u> of peas in A is greater than the volume of peas in B</p> <p>or</p> <p>the peas in A , are bigger / take up more space</p> <p>or</p> <p>the peas in A have absorbed water</p> <p>or</p> <p>the peas in B , are smaller / take up less space ;</p> <p>3 as without the beads there would be more , air / gas / oxygen , in B than in A ;</p>	2 max	<p>1 IGNORE ref to mass / weight</p> <p>2 IGNORE ref to mass / weight must refer to A / soaked / germinating and/or B / dry / dormant</p> <p>3 CREDIT idea that with the presence of beads the volume of gas would be the same</p>

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Question			Answer	Marks	Guidance
4	(b)	(ii)	<p>1 (determined by) finding difference in volume between (30) soaked , seeds / peas and (30) dry , seeds / peas ;</p> <p>2 the difference represents the volume of glass beads required</p> <p>or</p> <p>add the quantity of glass beads necessary to make the volumes (of respirometer contents) equal ;</p> <p>3 calculate / knowing , volume of 1 bead to determine number of beads equivalent to volume required ;</p>	2 max	<p>ACCEPT ref to mass/weight instead of volume throughout (ii) as an error carried forward (ecf)</p> <p>3 CREDIT any suitable <i>method</i> of determining the volume of beads required</p> <p>e.g. • displacement</p> <p>• put soaked peas in tube and measure volume; mark; then put dry peas in and add glass beads into tube and top up to mark</p>
4	(c)	(i)	0.014 ; ;	2	<p>Correct answer = 2 marks, even if no working</p> <p>If answer incorrect , not rounded correctly or given to more than 3 dp then</p> <p>ALLOW 1 mark for seeing</p> <p>• $\frac{0.27}{20}$</p> <p>or</p> <p>• 0.0135</p> <p>Only if there is no answer on the dotted answer line, should you look for the answer in the working or in the appropriate place in the table.</p>

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Question			Answer	Marks	Guidance
4	(c)	(ii)	<p>at, higher temperature / 25°C increased <u>kinetic</u> energy ;</p> <p>(named respiratory) enzymes / decarboxylases / dehydrogenases , involved ;</p>	2	<p>CREDIT ora for lower temperature</p> <p>IGNORE more collisions / ESCs</p> <p>Needs a clear statement that they are involved in <u>respiration</u></p> <p>IGNORE (named) co-enzymes</p>
4	(c)	(iii)	<p>1 reactions require aqueous medium / reactions need to take place in water / reactions need to take place in solution ;</p> <p>2 enzymes and substrates can move (to collide) in soaked seeds</p> <p>or movement (of reactants) , prevented / limited , in dry seeds ;</p> <p>3 soaked seeds need more , ATP / energy or dry seeds need less , ATP / energy ;</p> <p>4 for , protein synthesis / mitosis / other (named) metabolic reaction ;</p>	2 max	<p>ACCEPT 'germinating' for 'soaked', 'peas' for 'seeds', 'dormant' for 'dry' throughout</p> <p>1 IGNORE ref to reactants dissolving</p> <p>2 IGNORE ref to ESC as the mp is for the idea of mobility</p> <p>3 DO NOT CREDIT 'no' ATP / energy</p> <p>4 CREDIT soaked peas have increased metabolism IGNORE growth / respiration DO NOT CREDIT ref to photosynthesis</p>
			Total	12	