# 1.3 Organisms Exchange Substances with their Environment: 10-minute Pack

AQA 7402 · Calculator allowed · about 10 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

**Answer ALL questions. Show all your working.**

**1** A gas exchange surface must have specific structural adaptations to maximise the rate of diffusion, as described by Fick's law.

**(a)** State Fick's law of diffusion in words, identifying the three factors that determine the rate of diffusion. **(1)**

**(b)** An alveolus has a surface area of $1.8 \times 10^{-3}$ mm2 and its exchange surface (alveolar epithelium plus capillary endothelium) has a combined thickness of 0.50 micrometres. Under given conditions the rate of oxygen diffusion across this alveolus is $6.0 \times 10^{-6}$ arbitrary units. A patient develops pulmonary fibrosis, which thickens the exchange surface to 2.0 micrometres, with surface area and concentration difference unchanged. Calculate the new rate of diffusion. **(3)**

**(c)** Explain how emphysema, which destroys the walls between adjacent alveoli, reduces the rate of gas exchange, using Fick's law. **(2)**

**(d)** Explain how a high concentration gradient of oxygen across the alveolar epithelium is maintained during normal breathing. **(2)**

**(Total for Question 1 is 8 marks)**


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# Mark scheme · 1.3 Organisms Exchange Substances with their Environment: 10-minute Pack

## Question 1

(a) rate of diffusion is proportional to (surface area x concentration difference) / thickness of the exchange surface oe **B1**

**(a) Answer: Rate of diffusion is proportional to (surface area x concentration difference) / diffusion distance (thickness).**

(b) recognise rate is inversely proportional to thickness when surface area and concentration difference are constant **M1**

(b) new rate = old rate x (old thickness / new thickness) = $6.0 \times 10^{-6}$ x (0.50/2.0) **M1**

(b) $1.5 \times 10^{-6}$ arbitrary units, cao **A1**

**(b) Answer: $1.5 \times 10^{-6}$ arbitrary units**

(c) destruction of alveolar walls merges many small alveoli into fewer, larger air spaces, greatly reducing the total surface area available for gas exchange oe **B1**

(c) by Fick's law, a smaller surface area (with concentration difference and thickness roughly constant) directly reduces the rate of diffusion of oxygen into the blood oe **B1**

**(c) Answer: Emphysema destroys alveolar walls, reducing total surface area; since rate of diffusion is proportional to surface area, this reduces the rate of gas exchange.**

(d) ventilation (breathing in and out) continually replaces air in the alveoli with air of a higher oxygen concentration than the blood oe **B1**

(d) a good blood supply (dense capillary network) continually removes oxygenated blood and brings in deoxygenated blood, maintaining a low oxygen concentration on the blood side oe **B1**

**(d) Answer: Ventilation continually refreshes the air in the alveoli with oxygen-rich air, while a good blood supply constantly removes oxygenated blood and delivers deoxygenated blood, maintaining a steep concentration gradient.**


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