2.2 Movement of substances

Name: _____ Class: _____ Date: _____ **Total: 20 marks**

Objective

Build the skills to answer exam questions on **movement of substances in and out of cells** : diffusion, osmosis and active transport, the factors that affect them, and osmosis investigations with potato.

You must be able to:

- define diffusion, osmosis and active transport
- calculate surface area to volume ratio and percentage change in mass
- explain what happens to plant and animal cells in water and in strong solutions
- use results to find the concentration of cell contents

1 Key knowledge and worked examples

Moving substances

process	what moves	needs energy?
diffusion	particles, from a higher to a lower concentration	no
osmosis	water, from a dilute solution to a more concentrated solution, through a partially permeable membrane	no
active transport	particles, against a concentration gradient (low to high)	yes, from respiration
faster when	larger surface area to volume ratio, shorter distance, higher temperature, steeper gradient	
percentage change	(final − initial) ÷ initial ×100	

Worked example 1: percentage change. A potato piece goes from 2.50 g to 2.80 g. Find the percentage change.

1. Known: initial 2.50 g; final 2.80 g.

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2. Rule: change ÷ initial ×100.
3. Numbers: $0.30 \div 2.50 \times 100$.
4. Result: +12%.

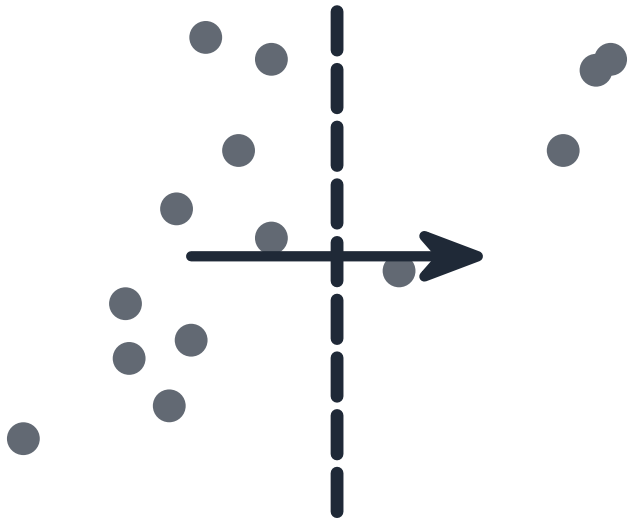
Worked example 2: surface area to volume. Find the ratio for a 2 cm cube.

1. Known: side 2 cm.
2. Rule: area = 6× side^2; volume = side^3.
3. Numbers: 24 cm^2; 8 cm^3; $24 \div 8$.
4. Result: 3 : 1.

Answer shapes: in osmosis, say where the water is more concentrated (the dilute side) and which way it moves.

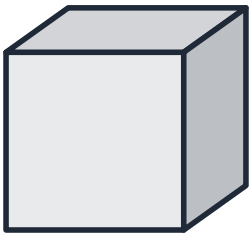
2 Practice

2.1 Define osmosis. [2]

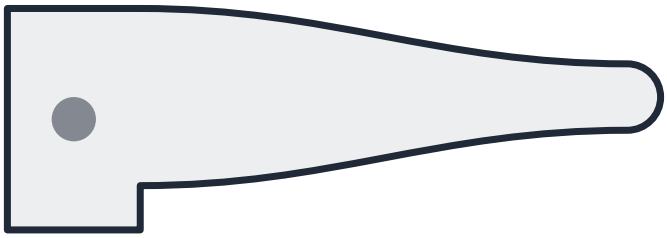


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2.2 Calculate the surface area to volume ratio of a 1 cm cube. [2]

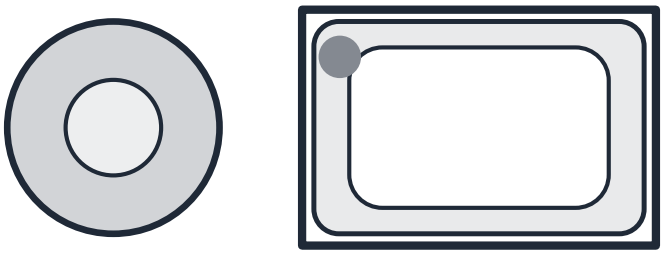


2.3 Explain why root hair cells take in mineral ions by active transport. [2]



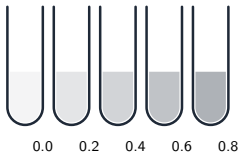
3 Exam-style questions

3.1 Explain why a red blood cell bursts in pure water, but a plant cell does not. [3]



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3.2 A student puts potato cylinders, each 2.00 g, into sucrose solutions for 1 hour, then dries and weighs them. The results are shown.



sucrose / mol dm^{-3}	0.0	0.2	0.4	0.6	0.8
final mass / g	2.30	2.12	1.96	1.80	1.70

(a) Calculate the percentage change in mass at 0.0 mol/dm^3 and at 0.8 mol/dm^3. [2]

(b) Use the results to estimate the concentration of the solution inside the potato cells. Explain your answer. [3]

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(c) Explain the changes in mass at 0.0 and 0.8 mol/dm^3, and describe how the student could make the results more reliable. [6]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- the net movement of water from a dilute solution to a more concentrated solution
- through a partially permeable membrane

2.2

- area 6 cm^2; volume 1 cm^3
- **6 : 1**

2.3

- the concentration of ions is lower in the soil than in the cell
- so ions must move against the gradient, using energy from respiration

3.1

- water enters both cells by osmosis
- the red blood cell has no cell wall, so it swells until the membrane bursts
- the plant cell wall is strong and stops the cell bursting; the cell becomes turgid

3.2

(a) $0.30 \div 2.00 \times 100 = +\mathbf{15}\%$; $-0.30 \div 2.00 \times 100 = -\mathbf{15}\%$

(b) about 0.35 mol/dm^3 (accept 0.3–0.4); the mass rises at 0.2 and falls at 0.4, so no change lies between them; at that concentration there is no net movement of water, because the concentrations inside and outside are equal

(c) points to include:

- at 0.0 the water outside is more dilute than the cell contents (K)
- water moves into the cells by osmosis, so the mass rises (An)
- at 0.8 the solution is more concentrated than the cell contents (K)
- water moves out of the cells by osmosis, so the mass falls; cells become flaccid or plasmolysed (An)
- reliability: use three cylinders for each concentration and calculate a mean (App)
- blot each cylinder dry the same way before weighing; use cylinders of the same size from the same potato (App)

Levels: **5–6** a full, logical answer with correct biology and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.

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