Model Answers: Hard

1

The correct answer is **A** because:

- Between **X** (photosynthetic cells in the leaf) and **Y** (companion cell) sucrose is moved against the concentration gradient – therefore the transport must be active (i.e. transport that requires ATP)
- At **Z (**a sieve tube element near a source) there is a high concentration of sucrose (due to the active transport of sucrose into **Y**), which **lowers** the water potential in the sieve tube element. This low water potential causes water to move in from the xylem and the pressure at **Z** to **increase** (and this provides the driving force behind translocation)hydrostatic
- At **T (**a sieve tube element near a sink) sucrose is actively transported out of the sieve tube element. This removal of solutes causes an increase in water potential and therefore a resulting **decrease** in pressure as water moves out of the sieve tube element (due to the increased water potential)

2

The correct answer is **C** because:

- Diffusion, mass flow and osmosis are present in the movement of **both** the xylem and the phloem

Diffusion is the net movement of molecules from a region of higher concentration to a region of lower concentration, down a concentration gradient

Mass flow is the movement of fluids down a pressure gradient

Osmosis is the net movement of water molecules across a partially permeable membrane from a region of higher concentration to a region of lower concentration

3

The correct answer is **A**

The first step is to work out how far the meniscus has moved in 30 minutes - it moves 3 mm per minute so **3 x 30 = 90 mm**

The next step is to work out the volume of water that is present in 90 mm of capillary tubing. The lumen inside the capillary tube is a cylindrical shape, so we need to calculate the volume of a cylinder 90 mm in length and 0.5 mm in diameter

The formula to calculate the volume of a cylinder is **πr^2 x height**

r = radius (which is half of the diameter) so we end up with the following calculation

$\pi 0.25^2$ x 90 = 17.67 mm^3

17.67 mm^3 rounded to two significant figures = **18 mm^3**

4

The correct answer is **C** because:

- Mass flow is the movement of fluid due to a **hydrostatic pressure gradient**
- This indicates that the liquid in the **phloem** is under hydrostatic pressure
- This hydrostatic pressure is greater at the source then the sink, which establishes a pressure gradient driving the flow direction

5

The correct answer is **C** because:

- As transpiration increases so does the **transpiration pull**
- This creates a **negative pressure** in the xylem vessel element
- The **lignin** in the xylem vessel element **strengthens** the walls and prevents the xylem from **collapsing** from this low pressure (much like the cartilage rings in the respiratory system)

6

The correct answer is **B** because:

- to move anything **against** a concentration gradient requires **energy** (and is called **active** transport), therefore the loading of sucrose into the phloem against its concentration must be an active process

A is incorrect as just because something is moving against gravity doesn't mean that it is an active process (i.e. water in the xylem moves against gravity, yet is a passive process)

C is incorrect as this indicates mass flow is occurring, but does not imply that the process is active

D is incorrect as the movement of water due to osmosis is a passive process

7

The correct answer is **C** because:

- **Plasmodesmata** are narrow threads of cytoplasm that pass through the cell walls of adjacent plant cells, therefore when water moves via the plasmodesmata it is passing through the **symplast** pathway
- In the **endodermis** in a root there is the **casparian strip** (a waterproof barrier composed of suberin) which blocks the apoplast pathway, so all water crossing the endodermis must travel via the **symplast** pathway
- When water passes through cell membrane into cytoplasm it is now in the **symplast** pathway
- When water enters a plants cell wall it is now in the **apoplast** pathway

- The **apoplast pathway** is movement of water via the cell wall
- The **symplast pathway** is movement of water vis the cytoplasm
- The **Casparian strip** is located within the endodermis of plant roots
    - Its function is to block the movement of water via the apoplast pathway, which forces water and dissolved solutes to pass into the cell and thus to be subjected to the action of plasma membrane transport proteins (which allows control over what is entering the plant)

8

The correct answer is **C** because:

- Water only moves up the **xylem** once the water that was in the leaf has evaporated (as there is now space for it to move into) therefore this is the key factor in determining the rate
- Numerous other factors (such as temperature and humidity) may change the rate at which water evaporates from the **mesophyll** (thus indirectly influencing the rate of water movement in the xylem), but ultimately the speed is determined by the evaporation from the mesophyll cells in the leaves

9

The correct answer is **B** because:

- Sucrose is a **non-reducing** sugar, which means it is **less** reactive and makes it a better transport molecule. Due to its inertness, it is more likely to survive the journey in the phloem (and no intermediate reactions with other molecules occur)
- In contrast, glucose is **more** reactive and can form other products during transport
- **A** is incorrect as sucrose is **not** easier than glucose to convert into starch as the **fructose** molecule in sucrose must first be changed back into a glucose before starch can be made

- **C** is incorrect as **neither** glucose nor sucrose can pass through a cell membrane as they are both **polar**
- **D** is incorrect as sucrose is **soluble**

Why does the plant not use maltose for transport instead of sucrose?

Although this might seem to make more sense (as maltose would be easier to convert to starch on arrival), remember that maltose (like glucose) is also a reducing sugar, therefore would be more likely than sucrose to react on route

Recap Translocation:

Sucrose is actively transported into the phloem by the companion cells. The sucrose then diffuses into the neighbouring sieve tube cells. Water molecules in the xylem diffuses into the sieve tube cells increasing the **hydrostatic pressure** in these cells and causing water to flow carrying any solutes with it (**mass flow**). It is this pressure which forces the sugar and water through the phloem. The sucrose is delivered to fruits, roots and any other parts of the plant needing energy.

10

The correct answer is **D** because:

- Root pressure is a **hydrostatic** force that pushes water up the xylem (and works in conjunction with the transpiration pull from the leaves)
- Root pressure depends on the **active transport** of ions into the xylem vessel elements, which is a process that requires **ATP**
- If the soil has little oxygen, aerobic respiration cannot occur so there will be less available ATP
- Therefore there is less **active** transport of ions into the xylem, less osmosis and a lower hydrostatic pressure