National Exams May 2015

04-Agric-A1, Applied Plant Physiology

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is A CLOSED BOOK EXAM.
   Candidates may use one of two calculators, the Casio or Sharp approved models.

3. All SIX (6) questions constitute a complete exam paper totaling 100 marks.

Marks

12 1) Please match the following plant tissues and cell types with the appropriate descriptions.

Pith and Cortex:	______	A) Paranchymal cells
Xylem and Phloem:	______	B) Sclerenchymal cells
Epidermis:	______	C) Collenchymal cells
Cells that perform metabolic functions:	______	D) Dermal tissue
Cells that support young plant shoots:	______	E) Vascular tissue
Cells with thick secondary walls that provide structural support:	______	F) Ground tissue

8 2) With words and/or diagrams, describe the process of photosynthesis. Your answer should contain an explanation of the roles and functions of Light Reaction and the Calvin Cycle.

15 3) Water spontaneously moves from an area of higher water potential (energy) to an area of lower water potential (energy). The solute potential (ψs) is the effect of dissolved substances on the potential energy of a solution. It is defined as 0 MPa for distilled water. For solutions the solute potential is determined by the Van't Hoff Equation, $\psi s = - C i RT$, where C is the molar concentration of the solute, i is the ionization constant for the solute, R is a constant and T is the absolute temperature (°K). RT = 2.436 @ 20 °C. Assume the concentration of solute (cytoplasm) in a plant cell is 0.3 M. If a cell is placed into a volume of pure water at STP:

a) What are the values of ψs and ψp of the water?

b) Calculate ψ at equilibrium.

c) Is the water hypertonic or hypotonic solution relative to the cell

15 4) Explain the effect of photoperiodism on flowering of plants and the role of red light in regulation of flowering in “short-day” and “long-day” plants.

30 5) Daily light integral (DLI) is the amount of photosynthetically active (PAR) light received each day as a function of light intensity (instantaneous light: $\mu mol \cdot m^{-2} \cdot s^{-1}$) and duration (day). It is expressed as moles (mol) of light (photons) per square meter (m^{-2}) per day (d^{-1}), or $mol \cdot m^{-2} \cdot d^{-1}$ (mol/day).

In Canada and the northern United States of America, daily light integral can range between 1-50 moles/day through the year depending on season and cloud cover. Transmission of light into the greenhouse is usually in the range of 35 to 75%. In other words, if sunlight provides 1000 $\mu mol \cdot m^{-2} \cdot s^{-1}$ outside the greenhouse, with a light transmission of 50%, then only 500 $\mu mol \cdot m^{-2} \cdot s^{-1}$ will reach the leaves of the plants on a greenhouse bench. In Manitoba during the winter months, DLI values seldom exceed 15 $mol \cdot m^{-2} \cdot d^{-1}$. For example, the minimum outdoor DLI in January in Manitoba is 10 $mol \cdot m^{-2} \cdot d^{-1}$.

Lets assume you want to grow tomatoes in a greenhouse with a double-layered polyethylene covering in Manitoba in January. The recommended minimum DLI for tomato production is 15 $mol \cdot m^{-2} \cdot d^{-1}$. If the transmission of light through a double-layered polyethylene covering is 76%, calculate:

a) the minimum DLI exposure of the tomato plants in the greenhouse;

b) the amount of supplemental lighting required for the tomato plants

20 6) Based on the previous calculations, you now know how much light is getting through the greenhouse cover to the tomato plants and how much supplementary DLI you will need to grow your tomato plants successfully. If Blue/Red LED lights have a combined quantum output of 0.51 $\mu mol \cdot m^{-2} \cdot s^{-1}$, calculate the number of Blue/Red LED lights you will need to provide the amount of supplemental lighting (in $mol \cdot m^{-2} \cdot d^{-1}$) required for the tomato plants.

100