Candidate Number:……

Candidate Name:……

Centre Number/Name:……

RHS LEVEL 3 ADVANCED CERTIFICATE IN HORTICULTURE
WRITTEN EXAMINATION

2:00pm Tuesday 3rd July 2007

IMPORTANT – Please read carefully before commencing.

i) The duration of the papers in Module **B** is **2 hours**.
ii) Answer **ALL** questions in Section **A**.
iii) **ALL** questions in Section **A** carry equal marks.
iv) Write your answers legibly in the spaces provided.
v) Use metric measurements **ONLY**.
vi) Where plant names are required, they should include genus, species and where appropriate cultivar.

MODULE B

Plant Taxonomy, Morphology & Anatomy
Plant Physiology
Plant Health

Section A – Short Answer Questions

ANSWER ALL QUESTIONS

MARKS

Q1 List **FOUR** necessary precautions to be taken in order to prevent high pesticide residues remaining on harvested food crops following application. **2**

……

……

……

……

……

Q2 Name **ONE** different herbicide that may be used to control the named weed in **EACH** of the following situations:

i) *'Bellis perennis'* in an ornamental lawn;
ii) *'Senecio vulgaris'* in fallow soil;
iii) *'Elymus repens'* in an established shrub border;
iv) *'Poa annua'* on a gravel driveway. **2**

……

……

……

……

……

Q3 Name **ONE** biological control for **EACH** of the following pests:

i) cabbage white butterfly;
ii) field slug;
iii) peach potato aphid;
iv) vine weevil. **2**

……

……

……

……

……

Please see over/…..

ANSWER ALL QUESTIONS

MARKS

Q4 State **FOUR** environmental conditions, which may cause a reduction in the rate of photosynthesis in protected structures of plants. **2**

……

……

……

……

……

Q5 State the difference between a tropism and a nastic movement in plants. **2**

……

……

……

……

……

Q6 Explain the physiological effects on transpiration as a result of **EACH** of the following horticultural practices in protected environments:

i) damping down;
ii) shading. **2**

……

……

……

……

……

ANSWER ALL QUESTIONS

MARKS

Q7 Explain the difference between a variety and a cultivar in plant nomenclature. **2**

.....

.....

.....

.....

.....

Q8 State **TWO** functions of medullary rays in woody stems. **2**

.....

.....

.....

.....

.....

Q9 Explain the difference between endospermic and non-endospermic seeds and name **ONE** plant example of **EACH**. **2**

.....

.....

.....

.....

.....

Q10 State **ONE** difference between the seed dispersal mechanisms of a dehiscent and an indehiscent fruit and name **ONE** plant example of **EACH**. **2**

.....

.....

.....

.....

.....

****

RHS LEVEL 3 ADVANCED CERTIFICATE IN HORTICULTURE
WRITTEN EXAMINATION

2:00pm Tuesday 3rd July 2007

IMPORTANT – Please read carefully before commencing.

i) The duration of the papers in Module **B** is **2 hours**.
ii) Answer **ONE** question from **EACH** of the sections **B**, **C** and **D**.
iii) **ALL** questions carry equal marks.
iv) Write your answers legibly in the answer booklets provided.
v) Use metric measurements **ONLY**.
vi) Where plant names are required, they should include genus, species and where appropriate cultivar.

MODULE B

Plant Taxonomy, Morphology & Anatomy
Plant Physiology
Plant Health

Sections B, C & D

Structured Questions

Please turn over/…..

Section B – Plant Taxonomy, Morphology & Anatomy

Answer ONE question only from this section

MARKS

Q1 a) Describe the process of secondary thickening in the stem of a **NAMED** woody plant species. Use clearly labelled diagrams to illustrate the answer. **16**

b) Explain how secondary thickening in a root, differs from the same process in the stem. **4**

Q2 a) Name and describe the range of plant structures adapted to store carbohydrate, using **SIX NAMED** plant examples. **12**

b) Describe the anatomical and physiological changes, which take place in the storage organ of *Narcissus* during the course of one year. **8**

Section C – Plant Physiology

Answer ONE question only from this section

MARKS

Q3 a) Describe the properties of semi-permeable membranes in plants. **8**

b) Explain how water and solutes are transported within the plant, in relation to **EACH** of the following:

i) osmosis;
ii) diffusion;
iii) water potential;
iv) transpiration. **12**

Q4 a) Explain the mechanism and role of respiration in plant metabolism. **8**

b) Compare the process of aerobic and anaerobic respiration in plants and state the relationship between respiration and photosynthesis. **12**

Section D – Plant Health

Answer ONE question only from this section

MARKS

Q5 a) Describe the visual symptoms of a **NAMED** plant virus on a **NAMED** host plant. **4**

b) List and describe **FOUR** methods of virus transmission in plants. **8**

c) Review **FOUR** methods of avoiding virus infection in plants. **8**

Q6 a) List **FOUR** pests of plants grown in a greenhouse and name an appropriate biological control for **EACH**. **8**

b) Describe a biological control programme for **ONE** of the pests listed in a), under **EACH** of the following headings:

i) life cycle of the pest; **3**
ii) environment; **3**
iii) introduction of biological control agent; **3**
iv) monitoring. **3**

****

RHS LEVEL 3 ADVANCED CERTIFICATE IN HORTICULTURE
WRITTEN EXAMINATION

Tuesday 3rd July 2007

MODULE B
Plant Taxonomy, Morphology & Anatomy
Plant Physiology & Plant Health

Examiners Report

Candidates Registered	308				
			Total Candidates Passed		
Candidates Entered	248	80.52%	Passed with Commendation	33	13.31%
Candidates Absent	48	15.58%	Passed	114	45.97%
Candidates Deferred	6	1.95%	Failed	101	40.72%
Candidates Withdrawn	6	1.95%			

Section A – Short Answer Questions

Q1 List **FOUR** necessary precautions to be taken in order to prevent high pesticide residues remaining on harvested food crops following application.

Many candidates incorrectly referred to post harvest and post marketing (domestic) precautions. The question required candidates to refer to precautions of good working practices which can be employed during the crop production phase, up to the point of harvest in order to reduce or prevent high pesticide residues remaining.

Similarly answers suggesting the use of organic growing systems or no pesticide regimes were incorrect in the context of the question set. Candidates should refrain from giving opinions about rights and wrongs of using pesticides when these are not asked for in the question. Too many candidates were unable to list four precautions necessary to prevent high pesticide residues remaining on harvested food crops and consequently failed to gain full marks.

Valid answers which would have attracted marks include:

- Read and follow label recommendations.
- Use correct pesticide dilution rates for the crop.
- Avoid using worn spray nozzles.
- Use correct application pressures.
- Observe harvest interval (HI) recommended.
- Keep product/ spray mixture agitated.

Other valid answers also gained marks.

Q2 Name **ONE** different herbicide that may be used to control the named weed in **EACH** of the following situations:

v) *'Bellis perennis'* in an ornamental lawn;
vi) '*Senecio vulgaris'* in fallow soil;
vii) *'Elymus repens'* in an established shrub border;
viii) *'Poa annua'* on a gravel driveway.

Although a number of candidates gave good answers gaining full marks, most candidates answers reflected a weakness in this subject area. In this context many candidates failed to demonstrate an understanding of the herbicides modes of action and the weed type and cropping situations on which they are designed to be used. On too many occasions candidates incorrectly recommended the use of specific fungicides or insecticides for weed control. Frequently the same herbicide product was quoted more than once to answer different parts of the question set. This was incorrect as the question required a different herbicide for each of the cropping situations listed. Candidates are recommended to give this subject are more revision time.
Valid answers to the question set would include:
i) Bellis perennis in an ornamental lawn - This required the choice of selective lawn weed killers to kill this broadleaved weed and leave the lawn grasses undamaged. Examples of suitable herbicides include, 24D, MCPA, Dicamba, Mecoprop etc.
ii) Senecio vulgaris in fallow soil – This is an annual weed growing in fallow soil which is likely to be required for sowing or planting into. Translocated or residual herbicides are undesirable but contact herbicides would give control without leaving residues behind. Suitable herbicides include Paraquat or diquat but other valid examples were awarded marks.
iii) Elymus repends in an established shrub boarder – This is a perennial grass weed requiring a translocated herbicide treatment to control the underground rhizomes. Valid answers most frequently and correctly gave the active ingredient glyphosate but those who suggested dichlobenil (Casoron G) a very effective residual also gained marks, other valid answers were also awarded marks.
iv) Poa annua on a gravel driveway – This is an annual grass weed growing in a non-crop situation. Controls for this would normally require the use of contact or residual herbicides or combinations of the two. Candidates gaining marks frequently quoted herbicide examples which included paraquat, diquat, dichlobenil and diuron etc. Other valid answers were allowed. Glyphosate was designed to control perennial weeds, and although it would control Poa annua weed, answers which quoted the product did not attract marks in the context of the question set.

Q3 Name **ONE** biological control for **EACH** of the following pests:

v) cabbage white butterfly;
vi) field slug;
vii) peach potato aphid;
viii) vine weevil.

On too many occasions candidates incorrectly gave cultural or physical control options for the pests listed. Likewise some candidates gave examples of naturally occurring (native) predator organisms eg. Hoverflies and ladybirds which was not required as these are not readily available from commercial sources and natural populations vary in numbers widely due to a range of external factors.
Candidates who correctly named predators or parasitic organisms available from biological supply companies in their answers gained marks, Examples of answers which attracted marks included the following:
i) Cabbage white butterfly – Bacillus thuringiensis (Dipel DF)
ii) Field slug – Phasmarhabditis hermaphrodita (Nemaslug)
iii) Peach potato aphid – Aphidius colemani and other species, (Aphidoletes aphidimyza)
iv) Vine weevil – Heterorhabditis megidis, Steinemema Kraussi '(Nemasys H)

Other valid answers for each section above received marks, marks were apportioned for named organisms.

Q4 State **FOUR** environmental conditions, which may cause a reduction in the rate of photosynthesis in protected structures of plants.

Many candidates demonstrated a good knowledge of this subject area and were clearly able to apply scientific principles to the practise of horticulture. Full marks were therefore frequently awarded for this question. Those candidates who failed to gain marks or achieved low marks were those who could not give four conditions responsible for a reduction in the rate of photosynthesis. More frequently it was those candidates who identified four factors but failed to quantify or qualify the examples given, for example it was correct to identify carbon dioxide and light but for marks to be awarded the examiner needed the candidate to say whether high or low levels of each would cause a reduction in the photosynthetic rate under protection.
Those gaining marks were able to state good examples of environmental conditions which included:
1) Excessively high temperatures
ii) Excessively low temperatures
iii) Reduced carbon dioxide levels
iv) Dry soils or compost (water stress)
v) Reduced light levels however caused
vi) Deficiencies of nitrogen, magnesium, iron etc resulting in leaf chlorosis and reduced photosynthesis.
Other valid answers gained marks.

Q5 State the difference between a tropism and a nastic movement in plants.

Candidates' answers indicated they are more conversant with tropisms than with nastic movements in plants. Consequently they were not readily able to state the difference between the two which was the purpose of the question. Candidates frequently gave examples of tropic and nastic responses in plants which was helpful where these supported a description of the difference between the two. Unfortunately marks were not awarded for examples of tropic and nastic movements in plants alone and where an explanation of the difference was lacking. Candidates' answers attracting marks were those which indicated that tropic movements are a plants response, in particular direction, towards an external stimulus which usually involves a bending movement with differential rates of growth towards a stimulus such as gravity, light, water etc. Conversely natstic movements are a plants response to a number of stimuli which do not come from any particular direction for example temperature, humidity, the day / night, responses of leaves and flowers to light levels and leaf closing responses to touch as seen in insectivorous plants (Venus fly traps) and the sensitive plant (Mimosa pudica).

Q6 Explain the physiological effects on transpiration as a result of **EACH** of the following horticultural practices in protected environments:

iii) damping down;
iv) shading.

A number of candidates did not answer the question set when they incorrectly referred to the physiological effects of 'damping down' and 'shading' on photosynthesis and respiration rather than transpiration asked for in the question. In these cases marks were not awarded. Many candidates answered this question well indicating good knowledge transfer between scientific principles and the practice of horticulture. Full marks were frequently achieved in answers to this question. Those candidates gaining full marks were able to explain that the physiological effects of each practise was to reduce or slow down the rate of water loss by transpiration. Both practises help to de-stress plants under high temperature (protected) conditions and maintain cellular turgidity and in turn plant turgidity. Candidates should be aware that both 'damping down' and 'shading' are done under protected structures during periods of bright light, high temperatures and dry atmosphere conditions to cool plant surfaces and reduce the rate of water loss by transpiration. Candidates failed to gain marks when they indicated that the rate of transpiration would increase.

Q7 Explain the difference between a variety and a cultivar in plant nomenclature.

Most candidates failed to gain full marks for the question because they were either unable to identify the differences clearly enough or gave imprecise or in some cases confused answers. A number of candidates incorrectly indicated that cultivars were the result of crossing two distinct species within a genus. This would result in an inter-specific hybrid and not a cultivar. These candidates gaining full marks were able to identify one or more of the following ways in which varieties and cultivars differ from each other.

<u>Variety</u>

i) This is an internationally accepted taxonomic classification unit in botanical nomenclature.
ii) A Variety is natural variation from a true species.
iii) Varieties occur naturally in nature within species grouping often as a result of isolation, geographical or topographical distribution.

<u>Cultivar</u>

i) Cultivars are not recognised as a unit of botanical classification internationally.
ii) Cultivars are considered to be of garden or horticultural importance only.
iii) Cultivars are often the result of artificial hybridisation (man-made)
iv) Some cultivars may be selected out from wild (natural) communities because of special garden attributes such as flower colour, leaf texture, variegation etc.

Q8 State **TWO** functions of medullary rays in woody stems.

Many candidates found difficulty with this question with most being able to identify only one function of the two required. Those candidates gaining full marks were able to identify two distinct functions from a range of options some of which are listed as follows:
i) Medullary rays help to 'seal off' or compartmentalise plant tissues from invasive attacks of pest or disease pathogens.
ii) Medullary rays form a gaseous connective pathway linking the surface bark lenticels with living inner tissue to convey oxygen for cellular respiration.
iii) they transport sugars from the phloem tissues to the inner living cells of the sapwood for the purpose of respiration.
iv) Medullary rays help in the movement of the soluble pre-cursors of tannins, resins and dyes to the heartwood.
Other valid answers gained proportionate marks.

Q9 Explain the difference between endospermic and non-endospermic seeds and name **ONE** plant example of **EACH**.

Many answers were comprehensive and accurate in detail with correctly identified examples. These received full marks.

Unfortunately there were a number of answers where lower marks were awarded or in some cases withheld completely. The candidates in such cases were aware of the basic differences between endospermic and non-endospermic seeds and their retrospective plant examples but had stated them under the wrong groupings. Marks could not be awarded where this occurred. The question set was straightforward and simply required candidates to state the differences between the two types of seed.
Answers achieving maximum marks included the following:
i) endospermic, seeds have their food store contained within the specialised endosperm tissue and not in thickened cotyledon leaves. A frequently quoted example would be Zea mays but other valid answers were awarded marks.
ii) Non-endospermic seeds have their food store contained within their thickened (fleshy) cotyledon leaves. A typical example of this would be the French bean Phaseolus vulgaris but other accurate examples gained marks.

Q10 State **ONE** difference between the seed dispersal mechanisms of a dehiscent and an indehiscent fruit and name **ONE** plant example of **EACH**.

Most candidates gaining full marks stated accurately the differences between the dispersal methods of both dehiscent and indehiscent fruits and gave accurate plant name examples for each.
Where candidates gained low or nil marks this was mainly due to otherwise accurate descriptions of differences and named plant examples being grouped beneath the wrong heading viz dehiscent and non-dehiscent. Those gaining high marks indicated that dehiscent fruits tend to dry out becoming hard and dry before splitting open (sometimes forcefully) to scatter their seeds around as seen in the legumes, brassica and poppy groups amongst others. They describe indehiscent fruit in contrast as having juices, succulent ovary structures which are eaten and distributed by animals and man or simply the fall to the ground and gradually decay before releasing their seeds as often seen in gooseberries, cherries, buttercups, strawberries etc.

Section B – Plant Taxonomy, Morphology & Anatomy

Q1 a) Describe the process of secondary thickening in the stem of a **NAMED** woody plant species. Use clearly labelled diagrams to illustrate the answer.

This question was chosen by 72% of candidates and some excellent answers were given with clearly labelled accurate diagrams. In part a) the anatomy of the young stem was well known although the cambium was sometimes labelled procambium or protocambium. Many were able to state that the first step in secondary thickening is the differentiation of interfascicular cambium from the parenchyma between vascular bundles. A common error was to sate that the vascular cambium grows out to form a ring. The subsequent activity of the cambium produced new xylem and phloem cells. However a better approach was shown by a minority who used diagrams to illustrate the division of cambial cells, whose outer and inner derivatives subsequently differentiate phloem and xylem respectively. Many students wrote that xylem vessels are alive, 'xylem cells become lignified gradually until the cell is dead and does not then perform its function in the translocation of water and nutrients'. In diagrams of the later stages of the process particularly there was some confusion between protoxylem, metaxylem and secondary xylem. Similarly the innermost complete ring of the xylem was often labelled primary xylem instead of the discrete remnants of the vascular bundles.
In general it was not known that the parenchyma of the medullary rays is produced by the division of the cambium. The medullary rays were usually inaccurately drawn as extending to the outside of the stem, in reality they should only be shown as extending to the outer edge of the primary phloem. Most answers were able to describe the appearance of annual rings, although very few referred specifically to a difference in the diameter of xylem vessels produced at different times. Most were agreed that the largest vessels are produced in the spring, but the smaller vessels were variously thought to be produced in summer, autumn or winter. There were some excellent descriptions of the differentiation and activity of the cork cambium although this rarely translated to a clear diagram. Secondary cortex was often omitted. It was also not generally known that lenticels are areas of loosely packed cork cells. Bark was usually thought to be synonymous with the cork layer.

b) Explain how secondary thickening in a root, differs from the same process in the stem.

Candidates were united in not being able to state how secondary thickening in the root differs from that in the stem. The different arrangement of xylem in the root was generally known but not the position of the cambium. It was also not known that a cork cambium differentiates from the pericycle, instead many stated that a root could not develop cork because it would interfere with the uptake of water.

Q2 a) Name and describe the range of plant structures adapted to store carbohydrate, using **SIX NAMED** plant examples.

28% of candidates chose to answer this question and the quality of answers was in general less than that of the answers to the first question.
In part a) although there were some good answers, the overall quality was not good for such a standard topic. In particular, it was common that bulbs were thought to be stems, Narcissus to have scale leaves, Cyclamen to be an example of a corm and a rhizome to be a modified root. It was important to specify the type of tuber represented by Dahlia, Solanum tuberosum and Cyclamen (root tuber, stem tuber and perennial tuber respectively) since this helps to avoid confusion. Plants were often given their common name rather than the botanical one e.g potato for Solanum tuberosum. Sometimes, as well the botanical name given was not specific enough e.g Solanum, Iris. On the other hand, some students realised that storage structures could include seeds and fruits although there was some confusion as to which structure (endosperm, cotyledon, pericarp, receptacle) actually stored the carbohydrate.

b) Describe the anatomical and physiological changes, which take place in the storage organ of *Narcissus* during the course of one year.

Although the basic sequence of events that occur in the bulb were reasonably well known, there was some difficulty with the timing. Comments that the foliage dies sown in autumn were quite common, although it was to be expected this would be contrary to their own experience of growing bulbs. It was seldom realised that the roots of the bulb develop in August/ September, if not before of the year previous to flowering. There was some confusion as to the structures that store the carbohydrate for the next season, very few scripts giving the present year's leaf bases as the answer.

Section C – Plant Physiology

Q3 a) Describe the properties of semi-permeable membranes in plants.

To obtain full marks answers should have included information on:
i) the structures of the semi-permeable membranes
ii) how semi-permeable membranes assist the absorption of water/solids

The majority of candidates provided information on why semi-permeable membranes are important but did not provide information on the actual properties.

b) Explain how water and solutes are transported within the plant, in relation to **EACH** of the following:

v) osmosis;
vi) diffusion;
vii) water potential;
viii) transpiration.

i) Osmosis – good answers were received from the majority of candidates. Some confusion was observed with the issue of concentrations. It was not clear with some scripts if the greater concentration referred to water or the nutrient solution.
ii) Diffusion – very good answers were observed demonstrating a good understanding of the term. Some candidates only recorded one aspect of diffusion ie. gas movement, the answer required gas and solids within water movement – very important in plant nutrition.
iii) Water potential – this provided a challenge for the majority of candidates. The answer required information on:
a) how water is moved within the plant
b) information on the energy potential of water, which will influence further water and solids movement in plants.
iv) Transport – very good answers received which demonstrated a good understanding of the topic. The relationship between water movement and environmental conditions was clearly explained by the majority of the candidates.

Q4 a) Explain the mechanism and role of respiration in plant metabolism.

The majority of candidates clearly explained the mechanism of respiration with good technical answers. The role of respiration was in many cases not recorded in candidate answers. The role of respiration is most important as it affects many other plant processes.

b) Compare the process of aerobic and anaerobic respiration in plants and state the relationship between respiration and photosynthesis.

Good answers were received in respect to aerobic respiration, a poor understanding of anaerobic respiration was shown, with very brief answers recorded. The affect of anaerobic respiration with plants would have very much assisted many scripts.
The relationship between respiration and photosynthesis provided good information by the majority of candidates. The marks for Section b) was 12 in total. The majority of the candidates allocated most of their time to Section a) which had a maximum mark of 8. Candidates are strongly advised to review the mark allocation for each part of the question.

Section D – Plant Health

Q5 a) Describe the visual symptoms of a **NAMED** plant virus on a **NAMED** host plant.

Most candidates were able to name a virus and specific plant host, higher marks were achieved by candidates who were able to give more than a generalised description of the visual symptoms relating to the named host.

b) List and describe **FOUR** methods of virus transmission in plants.

Many candidates gave several examples of viruses transmission between plants by mechanical means such as by hand and tools etc, there was also some general identification of insects as being responsible for virus transmission. There was opportunity to achieve higher marks where candidates were able to list and describe four distinctly different ways in which viruses are transmitted.

c) Review **FOUR** methods of avoiding virus infection in plants.

Candidates generalised about how virus infections can be mitigated, where candidates were able to outline workable strategies for dealing with virus transmission in plants high marks were given.

Q6 a) List **FOUR** pests of plants grown in a greenhouse and name an appropriate biological control for **EACH**.

Many candidates were able to achieve maximum marks in this part of the question.

b) Describe a biological control programme for **ONE** of the pests listed in a), under **EACH** of the following headings:

v) life cycle of the pest;
vi) environment;
vii) introduction of biological control agent;
viii) monitoring.

Part b asked candidates to demonstrate their knowledge of a named glasshouse pest life cycle and how this influenced the use of biological controls, candidates should be able to indicate the stage in the pest life cycle that a named biological control is introduced, with reference to the environmental influences both inside and outside the glasshouse. Candidates were expected to express their knowledge of the correct procedures for effective introduction of a named biological control into the greenhouse as well as practical methods of monitoring pest levels and the effectiveness of their biological controls.