LEVEL 3 ADVANCED CERTIFICATE IN HORTICULTURE
WRITTEN EXAMINATION

Tuesday 8th February 2011

10:00am – 12noon

MODULE A

Understanding of Plant Propagation Processes & Application of Soils, Growing Media & Plant Nutrition

Section A – Short Answer Questions

Candidate Number: ……

Candidate Name: ……..

Centre Number/Name: ……..

IMPORTANT – Please read carefully before commencing.

i) The duration of the papers in Module **A** 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.

ANSWER ALL QUESTIONS

MARKS

Q1 State **TWO** environmental requirements for the maintenance of seed viability for a **NAMED** plant. **2**

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Q2 State **FOUR** factors that affect soil development in the UK. **2**

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Q3 Identify **FOUR** stages in the breakdown of fresh wood chips after application as a soil mulch. **2**

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Q4 Distinguish between saturated soils and soils at field capacity. **2**

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Please see over/.....

MARKS

Q5 State what is meant by **EACH** of the following soil terms:

i) compaction;

ii) bulk density. **2**

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Q6 State **TWO** different uses for inert substances, in the cultivation of plants, and provide **ONE NAMED** example of each. **2**

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Q7 List **TWO** benefits and **TWO** limitations of growing plants using hydroponic methods. **2**

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Q8 List **FOUR** items of Personal Protective Equipment (PPE), with reasons for why the items are required, when applying bulky manures. **2**

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MARKS

Q9 State **FOUR** benefits of using plastic covers for propagation. **2**

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Q10 State **FOUR** physiological factors that have an effect on the quality of cutting material taken from a stock plant. **2**

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Royal Horticultural Society

RHS LEVEL 3 ADVANCED CERTIFICATE IN HORTICULTURE
WRITTEN EXAMINATION

Tuesday 8th February 2011
10:00am – 12:00noon

MODULE A

Understanding of Plant Propagation Processes & Application of Soils, Growing Media & Plant Nutrition

Sections B & C - Structured Questions

IMPORTANT – Please read carefully before commencing.

i) The duration of the papers in Module **A** is **2 hours**.
ii) Answer **ONE** question from Section **B** and **TWO** questions from Section **C**.
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.

Please turn over/.....

Section B – Understanding of Plant Propagation

Answer ONE question only from this section

MARKS

Q11 Explain the importance of **FIVE** of the following on the successful germination of seed using a **NAMED** example in **EACH** case:

i)	timing of seed collection;	**4**
ii)	temperature;	**4**
iii)	storage;	**4**
iv)	stratification;	**4**
v)	hygiene;	**4**
vi)	coating.	**4**

Q12 a) Name **TWO** plant examples normally propagated in **EACH** of the following facilities:

i)	fog unit;	**2**
ii)	mist unit;	**2**
iii)	heated bins.	**2**

b) Explain why **EACH** of the propagation facilities is most suitable for the plants named in a). **6**

c) Describe the propagation from selection of cuttings through to weaning of **ONE** of the above plant examples named in a). **8**

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Please see over/.....

Section C – Processes & Application of Soils, Growing Media & Plant Nutrition

Answer TWO questions only from this section

MARKS

Q13 a) Define the term 'soil structure'. **2**

b) Name and describe, **TWO** types of soil structure, with the aid of clearly labelled diagrams. **6**

c) Evaluate **EACH** of the two types of soil structure named in b), under **EACH** of the following headings:

i) soil air and water relationship; **6**
ii) plant growth. **6**

Q14 a) Explain how **EACH** of the following nutrients can be incorporated and held by growing media to benefit plant growth:

i) iron;
ii) calcium. **2**

b) State the causes of **EACH** of the following nutrient deficiencies:

i) chlorosis;
ii) poor flowering and fruiting;
iii) dead growing points and deformed leaves and flowers. **3**

c) For **EACH** of the deficiencies named in b), state a suitable source as used in horticulture. **3**

d) Explain, with examples, the relationship between nutrient availability and soil pH. **12**

Please turn over/.....

MARKS

Q15 a) State **FOUR** distinct drainage systems used in horticulture. **4**

b) Identify **ONE** advantage and **ONE** disadvantage of the use of **EACH** of the systems named in a). **8**

c) Identify **TWO** factors that affect the movement of water through **EACH** of the following:

i) the soil; **4**
ii) the drainage system. **4**

Q16 a) State **FOUR** reasons why alternative substrates to peat are sought in horticulture. **4**

b) Identify and describe the characteristics of **FIVE** materials which can replace some of the roles of peat in a potting compost. **10**

c) Describe the precautions which need to be taken when handling the materials identified in part b). **6**

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Royal Horticultural Society

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MODULE A

Understanding of Plant Propagation Processes & Application of Soils, Growing Media & Plant Nutrition

Candidates Registered	**83**		**Total Candidates Passed**	**48**	**84.21%**
Candidates Entered	57	68.68%	Passed with Commendation	12	21.05%
Candidates Absent	17	20.48%	Passed	36	63.16%
Candidates Deferred	7	8.43%	Failed	9	15.79%
Candidates Withdrawn	2	2.41%			

Section A – Short Answer Questions

Q1 State **TWO** environmental requirements for the maintenance of seed viability for a **NAMED** plant.

A clear statement of any two requirements, e.g. correct storage temperature (2- 4 degrees C) and moisture content (40- 45%) must have been related back to a named plant, e.g. *Quercus robur* for full marks.
General statements were made which did not relate to a named example or would cover germination, rather than viability.

Q2 State **FOUR** factors that affect soil development in the UK.

Any four clear factors stated, e.g. climate, time, parent material and biological activity, were accepted.
Other possible factors included: human interaction and plant species present. However, salinity was not accepted as a factor for soil formulation. Statements relating to the carbon and nitrogen cycles were taken as too general at Level 3.

Q3 Identify **FOUR** stages in the breakdown of fresh wood chips after application as a soil mulch.

Four clear stages should be identified e.g. uptake of nitrogen by bacteria; physical breakdown by feeding insects; environmental physical and chemical weathering and breakdown of lignin by fungi. Named examples were also rewarded.
However, a list of terms was sometimes forthcoming, e.g. mor and mull, without any background of how they relate to the situation provided.

Q4 Distinguish between saturated soils and soils at field capacity.

The differences between the two terms were required to be given, e.g. saturated soils; all the different sizes of pore spaces are full of water with surface run-off being seen. Therefore, an excess of water is present in the soil, resulting in root damage or death if the condition persists.

Field Capacity is the maximum water held by a soil after free drainage. Therefore, some air is present, usually the ideal state for plant water availability.

Q5 State what is meant by **EACH** of the following soil terms:

iii) compaction;

iv) bulk density.

Compaction is an increase in the bulk density of growing media which may prevent successful establishment of plant material. Some responses did not include that compaction will affect the quality of plant growth.

Bulk density is the physical mass of dried soil, per given volume, recording the balance between solids and spaces. Again, the level of detail was insufficient, e.g. the fact that the sample needs to be dried for the correct level to be calculated was overlooked.

Q6 State **TWO** different uses for inert substances, in the cultivation of plants, and provide **ONE NAMED** example of each.

Two clearly named substances, e.g. Perlite and expanded polystyrene were required with a suitable role for each, e.g. increased aeration and reduction in weight for growing media.

Some confusion was seen with the term ‘inert’ as substances highlighted included; coir. However, vermiculite and LECA were accepted, if suitable roles were included.

Q7 List **TWO** benefits and **TWO** limitations of growing plants using hydroponic methods.

Two clear benefits, e.g. contained system and controlled nutrient levels and two clear limitations, e.g. limited buffering capacity and high potential for quick disease spread, were rewarded with full marks.

Q8 List **FOUR** items of Personal Protective Equipment (PPE), with reasons for why the items are required, when applying bulky manures.

Any suitable four items were accepted, with clear reasons given, e.g. overalls, to prevent soiling of other clothes; gloves, to protect the hands from infection and soiling; steel-toe-capped boots, to protect the feet from being damaged or slipping and goggles / safety glasses, to protect the eyes from airborne material.
Other items, e.g. shovels and spades were not accepted as PPE. Also hard hats and full-face respirator were considered as outside the scope of the question set.
The term ‘long sleeves’ was taken as overalls.

Q9 State **FOUR** benefits of using plastic covers for propagation.

Any four clear benefits stated, e.g. low cost, re-usable, light in weight and prevention of water loss were given credit.
Other accepted responses included: humidity control; provides shade and weed control. It should be remembered that in some situations the temperature can be reduced under plastic covers.

Q10 State **FOUR** physiological factors that have an effect on the quality of cutting material taken from a stock plant.

Any suitable four factors were accepted, e.g. age of stock plant; age of cutting material; volume of stored carbohydrates and lignification / hormonal levels of cutting material.

Other statements considered acceptable, also included: free from pest and diseases (healthy plant) and true to type.
(genetically stable).

Responses such as: light quality; temperature; water availability and nutrient availability, were awarded some credit, although not strictly speaking physiological factors.

Understanding of Plant Propagation, Processes & Application of Soils, Growing Media & Plant Nutrition.

Sections B & C – Structured Questions

Section B – Understanding of Plant Propagation

Q11 Explain the importance of **FIVE** of the following on the successful germination of seed using a **NAMED** example in **EACH** case:

i) timing of seed collection;
ii) temperature;
iii) storage;
iv) stratification;
v) hygiene;
vi) coating.

Question aims and scope
This question is designed to test the candidate's knowledge of five key aspects relating to successful seed germination. This is then set in the context of a candidate's plant knowledge as each section requires the candidate to provide a suitable named plant example.

Examiners comments and recommendations
This question was generally well answered and candidates who considered the structure of the question and provided similar amounts of appropriate information for each section gave themselves the best chance of scoring highly. Included in each section must be a botanically correct, named plant example.
In each section it is important to keep relating back to the question so that for example the importance of hygiene is in the context of successful seed sowing and not seed storage. Stratification was on occasions confused with scarification. Both techniques regularly feature within exam questions so a firmer understanding of both is advisable.
'Coating' was answered in two ways, both equally appropriate. Some described seed coating to include pesticide applications while other candidates mentioned the significance of hard seed coats and the need to soften them to assist with the uptake of moisture.
Good information on seed treatments is contained within Hartmann and Kester's Plant Propagation: Principles and Practice, and a full list of IPPS conference papers relating to seed treatments and germination including abstracts can be found by going to www.ipps.org

Q12 a) Name **TWO** plant examples normally propagated in **EACH** of the following facilities:

i) fog unit;
ii) mist unit;
iii) heated bins.

b) Explain why **EACH** of the propagation facilities is most suitable for the plants named in a).

c) Describe the propagation from selection of cuttings through to weaning of **ONE** of the above plant examples named in a).

Question aims and scope
The aim of this question is to test the candidate's knowledge of propagation facilities and to place this in the context of an individual's plant knowledge both relating to each propagation facility and how to successfully root a named plant example within a chosen facility.

Examiners comments and recommendations
Fewer candidates selected this question however it was generally well answered and candidates who considered the structure of the question and provided the appropriate amount of relevant information relating to the number of marks on offer, for each section, gave themselves the best chance of scoring highly. Crucial to the success of this question is for the candidate to provide six named plant examples. Each pair of named plants needs to indicate to the examiner that the candidate understands the different rooting environments offered by each facility. Hardwood cuttings are rooted in a heated bin, low value, quick rooting subjects that cope with wetter conditions will feature on a mist system while high value, often more difficult to root subjects requiring high levels of humidity but less leaf wetness, are suited to a fog unit. The named plant examples need to fit these guidelines. There was some confusion around the understanding of a heated bin but in this context rooting house plants within a closed case would not be an acceptable interpretation, while the callusing of a range of fruit rootstocks in a garner bin, or the rooting of a number of tree and shrubs from hardwood cuttings would gain maximum marks.

In part c) those candidates who provided a full description of the propagation process through to weaning within one of the already discussed facilities scored well. However extending the description beyond weaning to potting off and growing on gained no additional marks. It is important to read the question carefully as describing the successful germination of a seed raised crop in one of the above facilities will similarly gain the candidate no marks. Good relevant information contained within Hartmann and Kester's Plant Propagation: Principles and Practice, and a full list of IPPS conference papers relating to propagation from cuttings, including abstracts, can be found by going to www.ipps.org
The RHS book Plant Propagation is an invaluable source of information.
Sound practical experience gained from working on a nursery or from attendance at practical workshops will provide candidates with the best chance of gaining top marks for this question.

Section C – Processes & Application of Soils, Growing Media & Plant Nutrition

Q13 a) Define the term 'soil structure'.

b) Name and describe **TWO** types of soil structure, with the aid of clearly labelled diagrams.

c) Evaluate **EACH** of the two types of soil structure named in b), under **EACH** of the following headings:

iii) soil air and water relationship;
iv) plant growth.

The aim of the question was to test candidates' knowledge of soil structure. Most candidates provided a brief definition of soil structure however some confused structure with texture and went on to define soil textural classes and described the properties of clay and sandy soils. In a few instances soil profiles were defined and described. Where a good definition of soil structure was given for part a) candidates tended to successfully describe two types of soil structure – blocky, plate-like and crumbly (spheroid) were the most popular choices. The highest marks were gained with clear accurate diagrams and good use of technical language.

Part c) was successfully answered by many candidates especially if parts a) and b) were correctly answered. Good answers related to soil porosity, aeration, nutrient status, water retention, drainage, water and air movement in soil, compaction, root growth, nutrient uptake and the impact on cultivation practices.

How soil structure types can be graded (structure-less, weakly developed, moderately and strongly developed) was cited by few candidates. Answers that started well, with a sound definition of soil structure, tended to end well with detailed evaluations.

Q14 a) Explain how **EACH** of the following nutrients can be incorporated and held by growing media to benefit plant growth:

i) iron;
ii) calcium.

b) State the causes of **EACH** of the following nutrient deficiencies:

i) chlorosis;
ii) poor flowering and fruiting;
iii) dead growing points and deformed leaves and flowers.

c) For **EACH** of the deficiencies named in b), state a suitable source as used in horticulture.

d) Explain, with examples, the relationship between nutrient availability and soil pH.

The aim of this question was firstly to test candidates' knowledge of some specific plant nutrients and then to test their knowledge of how pH affects levels of nutrient availability in soil.

Many candidates stated that iron is best applied as chelates and calcium as one of several compounds – ground limestone, Dolomitic limestone, magnesian limestone and organic matter that is rich in calcium i.e. manure. Full marks were given where candidates stated how these nutrients were then held by the soil colloids – cation exchange.

Most candidates were able to state at least one cause of chlorosis in plants – iron, potassium, nitrogen, copper or sulphur deficiency.

Most candidates stated that a lack of potassium was the main cause of poor fruiting and flowering. In addition to potassium, phosphorus and calcium were also correctly cited.

Boron deficiency was correctly identified by some candidates, Calcium and other nutrients were cited instead. Marks were given if this was explained and correctly related to specific symptoms.

Horticultural sources of the nutrients listed in b) were provided by most candidates. Basic compounds were cited as well as branded commercial products. Some compounds, such as ammonium nitrate, were cited but these are more agricultural than horticultural.

Part d) was answered most successfully by candidates who were able to correctly explain what pH means, in soil science, and how acidity or alkalinity affects the availability of named nutrients. Also, the pH range in garden soil was quoted and the optimum pH for most plants. Reference was also made to calcicoles and calcifuges, as another way of demonstrating knowledge of the subject.

Q15 a) State **FOUR** distinct drainage systems used in horticulture.

b) Identify **ONE** advantage and **ONE** disadvantage of the use of **EACH** of the systems named in a).

c) Identify **TWO** factors that affect the movement of water through **EACH** of the following:

iii) the soil;
iv) the drainage system.

Full marks were available (and in several cases scored) in **part a)** for identifying soakaways, pipe drainage (clay or plastic), mole drains and French drains. Sand slitting was accepted as was 'ditch' although the latter is usually part of a drainage *system*: 'intercept drainage ditch' is an example of a more precise answer.

Subsoiling is a method of cultivation which improves soil structure with incidental drainage effects and was not accepted as a 'drainage system'.

The answers to **part b)** were less precise. The syllabus requires candidates to be able to: *…describe a range of drainage systems for different soil types…*. To differentiate between systems it is necessary to know their strengths and weaknesses. Many candidates correctly pointed to the potential problem of blockages in pipe systems and there was general agreement about the use of mole ploughs. There was less certainty about the limitations of soakaways and much use of vague words like 'easy' and 'expensive'.

The question was seeking specific advantages and disadvantages, for instance:

Soakaway	Cheap, useful for spot treatment, simple to install.	Limited capacity, further movement of water limited by surrounding soil texture, structure and water table.
Tile Drain	Simple, modular, strong, resilient, long lasting.	Costly to install, heavy, labour intensive, (*not* fragile).
Perforated plastic drain	Simple, cheap, mechanised installation, flexible, range of diameters and thus capacity.	Can block long term, difficult to clean if blocked, less robust than clay or rigid plastic (especially in trafficked areas),
Pipe drain with backfill	Efficient, fast removal of water.	Doubles the cost of a simple pipe system.
Mole Drain	Fast, material-free.	Restricted soil types, temporary, powerful tractor required.
French drain	Simple method of draining flat impervious areas, efficient interceptor drain	Can become blocked, needs an outfall to be effective.

The factors in **part c)** were not well outlined. Not only are these factors relevant to the syllabus but they are critical for the successful performance of a drainage system. If such a system is thought of as a series of links, then the failure of any one link will cause the failure of the system.

The question was seeking the following factors:

Soil surface to drains: affected by existing soil texture, structure, compaction; possible interventions are: sand slitting, solid tining, hollow tining.
Into the drains: presence or absence of backfill. **Along the drains**: pipe type and diameter, fall and spacing. Pipe blockage, vermin traps, silt trap. **Outfall**: place for water to be dispersed. Grid to prevent animal ingress.

Q16 a) State **FOUR** reasons why alternative substrates to peat are sought in horticulture.

b) Identify and describe the characteristics of **FIVE** materials which can replace some of the roles of peat in a potting compost.

c) Describe the precautions which need to be taken when handling the materials identified in part b).

Part a) asked why horticulturalists are looking for peat alternatives. All candidates correctly pointed to environmental concerns both in terms of habitat and sustainability. Candidates scoring highly were precise about the nature of those concerns.

World wide there are very large deposits of peat and the use of peat as a growing medium is a relatively minor use. In the United Kingdom reserves of suitable peat are more limited and the surface stripping of lowland raised mires has destroyed habitat and damaged an important record of the past preserved in the peat.

A statement commonly made was that peat is a non renewable resource. Peat deposits contain irreplaceable biological and palaeo-climatic records but in terms of the material itself present extraction is non-*sustainable* because rates of extraction exceed natural renewal.

Extraction involves drainage so extracted areas are liable to be converted into other uses or degraded by drying out.

Peat bogs are a very large carbon sink, extraction allows the carbon to be oxidised and lost to the atmosphere as oxygen.

In addition to these environmental concerns, a range of other reasons were put forward relating to the limitations of peat. However, the reason that growers use (moss) peat is that it is a medium *par excellence,* having just the right combination of physical, chemical, aesthetic and economic properties for (short and medium term) container growing.

One candidate correctly stated that government policy is the phasing out of peat in horticulture. Social pressure based on environmental concerns was also accepted as a valid reason for seeking alternatives, especially in the amateur market.

In part b), a wide range of suitable materials were put forward and marks were awarded for those that have commercial or amateur use in this country. Where specific materials not in use in the UK have significance in other countries, these too were accepted.
However, the question states '*potting compost*' specifically – so uses relating to soil improvement were not accepted.

Of the main materials, bark and coir were mentioned most frequently.
Candidates who scored most highly distinguished the bark used for growing media as being composted, matured or aged (compared with bark chips used as mulches). Several understood the link with nitrogen lock up. Fewer referred to the variability according to species or the superior qualities of pine bark. Several referred to its cheapness whereas the opposite is the case. Answers also varied on its physical properties. A major advantage of bark is the drainage and aeration it imparts to composts.

A high air filled porosity was also correctly identified and a major advantage of coir; knowledge of other characteristics was less certain with several incorrect assertions about its buffering capacity and wettability.

Although no candidates mentioned the British Standard for composted green waste, a majority were aware of its use in horticulture and in particular as a growing medium constituent.

Loam was also mentioned, marks were gained for mentioning the need for partial sterilisation, the inherent variability relating to texture and the excellent buffering capacity.

In the final part of this question (part c), a wide range of precautions which should be taken when handling growing media were outlined. A minority of candidates were specific in attributing particular risks to particular materials and a sole reference was made to the generally hazard free nature of most growing media. There was one reference to hazard data sheets and none to reading the precautions printed on bagged materials. Many comments were made to steel toe cap boots, but marks were scored for referring to the one universal message on all bagged media 'take care when lifting'. In view of the 3 million days lost to musculoskeletal disorders[1] the promotion of correct lifting technique should carry some weight. One of the characteristics which could have been mentioned in part b), the weight or bulk density, would be particularly significant in loams, green composts and baled peat.

Another general precaution which was often ignored was the importance of hand washing after handling materials (whether or not gloved) and before eating or drinking.

Specific topics which attracted marks were the risk of abrasion in barks and other wood residue composts; green composts *should* be screened but the potential presence of glass or sharp plastic shards cannot be discounted. Dust is particularly associated with coir, as are potential pathogens in loam if not partially sterilised. The risks of *Legionella* in damp compost, which received some publicity last year is thought to be low.

When considering specific precautions there is also a need to be aware of the general (and by far the most common) hazards of cuts from sharp objects, slips and trips, and being hit by objects, including vehicles.

Some candidates interpreted the ‘precautions’ to apply to the material rather than personnel and marks were also allowed for references to the need to keep materials in cool dry conditions away from contact with herbicides and other chemicals.