National Exams May 2018

04-Agric-A1, Applied Plant, Animal or Human 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. FIVE (5) questions constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.

4. Each question is of equal value.

5. Full marks cannot be gained just by getting the "correct" answer. You must also communicate clearly how the problem is solved.

Marking Scheme

1. 5 marks for each term explanation.

2. 10 marks for (a) and 10 marks for (b).

3. The mathematical equation (with definitions/descriptions of parameters): 10 marks; discussion of parameter(s): 10 marks.

4. General trend of temperature effect: 2 marks; variation of energy intake: 4 marks; variation of metabolic heat production: 8 marks; variation of feed use efficiency (for growth): 6 marks.

5. Metabolizable energy intake: 2 marks; tissue dry matter calculation: 3 marks; energy retained: 5 marks; energy for growth: 5 marks; tissue gains: 5 marks.

6. Calculation of heat production using the measured air properties and the airflow rate: sensible heat: 7 marks; latent heat: 7 marks; scaling of boy mass for 2.5 kg chickens: 6 marks.

Marks

20 1. Explain the following terms:

a) Lower critical temperature
b) Thermoconformer
c) Piloerection
d) Photoperiodism

20 2. Describe and explain how an endothermic animal regulates its body temperature when the ambient temperature is: (a) below the thermoneutral zone, and (b) above the thermoneutral zone.

20 3. The metabolism is closely related to the body size of an animal. Describe the mathematical equation that is commonly used to relate the metabolic rate to body mass. Discuss the reasoning (at least one hypothesis) behind the value(s) of the parameter(s) in the mathematical equation.

20 4. From the point of view of energy use efficiency, describe and discuss how the environmental temperature may affect the growth of a pig. Your discussion should include the variations of energy intake and metabolic heat production with the environmental temperature (Draw curves to show these variations).

20 5. A pig is fed a total of 1.36 kg of feed per day, with 5% of wastage. The metabolizable energy (ME) content in the feed is 13.8 MJ/kg. The following conditions are assumed:

- energy partition: 43% of ME for growth; 57% for maintenance
- energetic efficiency of protein deposition = 0.511
- energetic efficiency of lipid deposition = 0.919
- energy retention of body lipid = 39.6 MJ/kg lipid
- energy retention of body protein = 23.7 MJ/kg protein
- energy content of non-fat visceral components (NFVC) = 23.7 MJ/kg NFVC
- dry matter (DM) content:
    - lean tissue DM content = 22%
    - fat tissue DM content = 90%
    - NVFC DM content = 22%
- lean tissue to fat to NFVC ratio in carcass is 1.00 to 0.29 to 0.35 (by mass).

Determine the daily growth of pig (the total daily mass gain of lean, fat and NVFC tissues).

20 6. A direct calorimeter is used to measure heat production by chickens. Five chickens averaging 2.0 kg are placed in the calorimeter. Conditioned air is introduced to the calorimeter at a rate of 1.5×10^{-3} m^3/s (measured at the inlet). The measured properties of air at the inlet and outlet are as follows:

At inlet:

- dry-bulb temperature: 10°C
- dew-point temperature: -3°C
- relative humidity: 38.8%
- humidity ratio: 0.00294 kg/kg
- entropy: 17.5 kJ/kg
- specific volume: 0.81 m^3/kg

At outlet:

- dry-bulb temperature: 24°C,
- dew-point temperature: 10°C
- relative humidity: 41.1%
- humidity ratio: 0.00763 kg/kg
- entropy: 43.6 kJ/kg
- specific volume: 0.85 m^3/kg

Determine the rates of sensible and latent heat production (W/kg) by chickens. Assume that heat losses through the walls of the calorimeter are negligible, specific heat of air is 1.0 kJ/kg.K, and heat of vaporization of water is 2257 kJ/kg.

Use the measured values to estimate the total sensible heat production by 3,000 chickens averaging 2.5 kg in a barn.