Silence Please

Do Not turn over this page until advised to by the Invigilator

CIT Semester 1 Examinations 2018/19

Note to Candidates:	Check the Programme Title and the Module Description to ensure that you have received the correct examination. If in doubt please contact an Invigilator.
Module Title:	**Maths for Biological Sciences**
Module Code:	**MATH6056**
Programme Title(s):	BSc Applied Biosciences Y1 BSc Hons Cmn Biological Sci Y1 BSc (Hons) Herbal Science Y1 BSc Hons Nutrtn & Hlth Sci Y1 BSc Hons Pharma Biotech Y1 BSc Agri-Sciences Y1 BSc Hons Agri-Biosciences Y1
Block Code(s):	**SBIOS_7_Y1** **SCEBS_8_Y1** **SHERB_8_Y1** **SNHSC_8_Y1** **SPHBI_8_Y1** **SAGBI_7_Y1** **SAGBI_8_Y1**
External Examiner(s):	**Dr. James Cruickshank**
Internal Examiner(s):	Ms. Mary Quirke, Ms. Gráinne Read, Dr. Justin Mc Guinness, Ms. Katie Bullen
Instructions:	Answer all four questions. Show all calculations in full.
Duration:	2 Hours
Required Items:	Calculator, Log/Formulae Tables

Question 1

(a) When using a diffraction grating, the wavelength of light, λ, is given by the formula:

$$n\lambda = d\sin\theta$$

where d is the distance between the lines on the grating, θ is the angular displacement of the image, and n is the order of the image.

(i) Transpose the formula to make d the subject.

(ii) Hence, if light of wavelength $\lambda = 6.0 \times 10^{-7} m$ is used, and the image is found at an angular displacement of $\theta = 64°9'$, when $n = 3$, find the distance d, between the lines of the grating. (Answer in SI units)

(iii) Also give your answer to part (ii) using Prefix Notation.

[9 marks]

(b)

(i) A company is considering buying new vehicles. They have been given a quote of €97700 for three new cars and four new vans. If a van costs €2700 more than a car, find the respective costs of a car and a van.

(ii) Solve the following equation for x: $\frac{x+2}{3} + \frac{x+5}{4} = \frac{5}{2}$

[8 marks]

(c) Answer the following questions, useful formulae are available at the back of the exam paper.

(i) A 350ml solution of hydrochloric acid has a molarity of 2.0M. The molecular mass of hydrochloric acid is 36.46g/mol. What mass of hydrochloric acid is required for this solution?

(ii) An aqueous solution has a concentration of 0.55g/l, what is this concentration in ppm (parts per million)?

[**8 marks]**

Question 2

a) Simplify the following expression, giving your answer with positive indices only

$$\sqrt{\frac{x^3 y^4 z}{x^7 y^2 z^{-3}}}$$

[5 marks]

b) Solve for x in each of the following (round your answer to 2 decimal places where appropriate)

i) $2^{3x-2} = 3^{2x+1}$

ii) $\log_3 (5x + 7) - \log_3 (x + 5) = 1$

[10 marks]

c) The amount of paracetamol in the bloodstream of a patient decays exponentially after administration; this decay is described by

$$C(t) = C_0 \, e^{-0.3466t},$$

where t is the time in hours, $C(t)$ is the amount (in mg) at a time t, C_0 is the dose administered initially (in mg).

i) If a 100mg dose is given to a patient, how much paracetamol is left in the patients bloodstream after 2 hours? Round to the nearest mg.

ii) The minimum therapeutic dose required for paracetamol to be effective is 20mg; below this level the drug has no effect. At what time after the initial dose of 100mg is this level reached, i.e. when should a second dose be taken by the patient?

[10 marks]

Question 3

(a) Differentiate each of the following by rule:

(i) $f(t) = 2t^4 + 3\ln t - \frac{1}{t^3}$

(ii) $y = \frac{\sqrt{x}}{2} - 3e^{4x}$

[7 marks]

(b) Given a curve $f(x) = x^3 - 27x$

(i) Find the coordinates of the two turning points on $f(x)$

(ii) Using differentiation, determine which point is a maximum and which point is a minimum.

(iii) Find the equation of the tangent to the curve at the point $(5, -10)$

[9 marks]

(c) The amount, in μg, of a certain medicinal drug in the bloodstream t hours after it has been taken can be estimated by the function:

$$f(t) = -t^3 + 4.5t^2 + 54t, \qquad where\ 0 \leq t \leq 9, t \in R$$

Use this function to determine:

(i) The amount of the drug in the bloodstream 4 hours after the drug has been taken.

(ii) The rate at which the drug amount is changing at 4 hours.

(iii) At 4 hours, is the amount in the bloodstream increasing or decreasing? Justify your answer.

(iv) The maximum amount of the drug in the bloodstream over the first 9 hours.

[9 marks]

Question 4

a) Reduce the following equations to their linear form and state for each (1) what would be plotted on the vertical axis, (2) what would be plotted on the horizontal axis, (3) the gradient and (4) the vertical axis intercept.

(i) $y = ax^4 + b$ where a and b are constants

(ii) The head of pressure h and the flow velocity v are measured and believed to be connected by the law $v = a\,h^b$, where a and b are constants.

(iii) The number of particles, N(t), emitted by a radioactive substance varies with time, t, according to the law $N(t) = a\,e^{-bt}$, where a and b are constants.

[10 marks]

b) Basal energy requirement B is the number of calories that a person needs to maintain the life process. B depends on the height, weight and age of the person. For a 28-year-old female with a height of 160 cm, B is a linear function of the person's weight w (in kilograms). For a weight of 45 kg, B is 1300 calories. For a weight of 50 kg, B is 1365 calories.

(i) Graph the linear relationship of B versus w.

(ii) What is the intercept of the y-axis?

(iii) Give the equation of this linear relationship.

(iv) What is the basal energy requirement for a 28 year old female with a height of 160 cm who weighs 60 kg?

[7 marks]

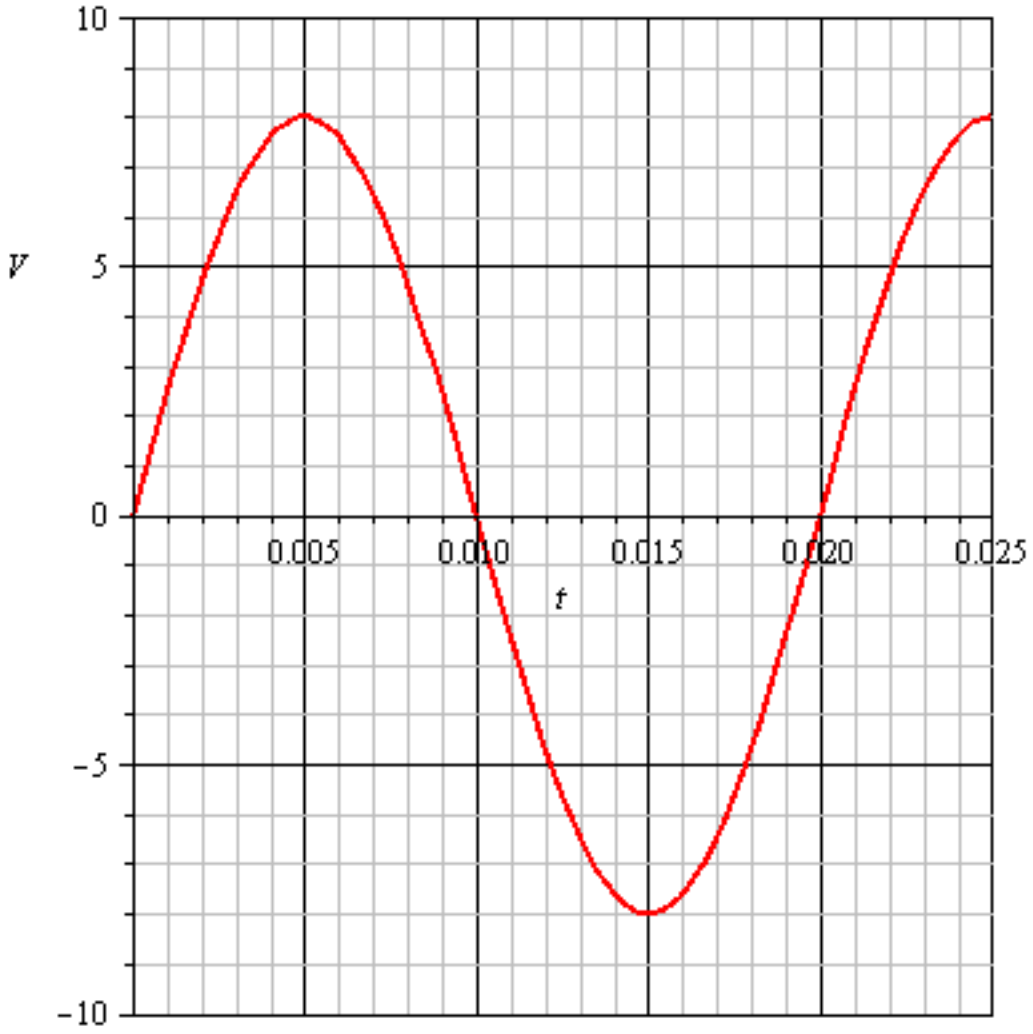
(c) Convert

(i) 160^0 to radians.

(ii) 4.2 radians to degrees. **[3 marks]**

Question 4 is continued on the next page

(d) The graph below shows *V (volts)* as a function of time *t (seconds).*



(i) State the amplitude (*A*), period (*t*) and frequency of *V.*

(ii) Hence express *V* in terms the function:

V = A Sin (ω *t*) where ω is the angular velocity (in radians per second).

[5 marks]

.

Expression of Concentration	Formula
Molarity $\mathrm{mol/L}$ or M	$\frac{\text{Moles of solute (mol)}}{\text{Volume of solution (L)}}$
Volume % (vol/vol %)	$\frac{\text{Volume of solute}}{\text{Volume of solution}} \times 100$ **Note**: units need to be consistent
Mass % (mass/mass %)	$\frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$ **Note**: units need to be consistent
Mass per volume %	$\frac{\text{Mass of solute (g)}}{\text{Volume of solution (mL)}} \times 100$ **Note:** Assumes solvent is water (mixes gram and mL since density of water 1g/mL)
parts per million (ppm)	$\frac{\text{Mass of solute}}{\text{Mass of solution}} \times 10^6$ **Note**: units need to be consistent **Note**: 1 ppm = 1 mg/L (assuming solvent is water)
parts per billion (ppb)	$\frac{\text{Mass of solute}}{\text{Mass of solution}} \times 10^9$ **Note**: units need to be consistent **Note**: 1 ppb = 1 µg/L (assuming solvent is water)

Table 1: Different Units for Expressing the Concentration of Solutions

Further equations for calculating concentration:

$$C_1V_1 = C_2V_2$$

$$density = \frac{mass}{volume}$$

$$Concentration\ (mol/l) = \frac{mass\ (g)}{Volume\ (l)} \times \frac{1}{molecular\ mass\ (g/mol)}$$

The density of water is assumed to be 1 g/cm³ or 1 g/mL. Therefore 1ml H_20 = 1 g or 1 cm³ H_2O = 1 g