CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ

Autumn Examinations 2015

Module Title: Heat and Light (CA)

Module Code: **PHYS6044**

School: Science

Programme Title: Bachelor of Science (Hons) – Herbal Science, Year 1
Bachelor of Science (Hons) – Nutrition and Health Science, Year 1
Bachelor of Science (Hons) – Pharmaceutical Biotechnology, Year 1
Bachelor of Science in Applied Biosciences, Year 1

Programme Code: **SHERB_8_Y1**
SNHSC_8_Y1
SPHBI_8_Y1
SBIOS_7_Y1

External Examiner(s): Mr Joe Haugh, Dr John Houlihan
Internal Examiner(s): Ms E. Baldwin

Instructions: **Section 1** **Answer All Questions,**
Section 2 **Answer any 3 Questions**

Duration: 2 hours

Sitting: Autumn 2015

Requirements for this examination:
Non programmable calculator allowed, Mathematical Tables allowed

Note to Candidates: Please check the **Programme Title** and the **Module Title** to ensure that you have received the correct examination.
If in doubt please contact an Invigilator.

Section 1

Answer all questions,
All questions in Section 1 are worth 2 marks each
Please mark your answers to Section 1 on the attached MCQ answer sheet

1. Which statement is ***true***?
    a. $25^oC = 230K$
    b. $1K = 1^oC$.
    c. Absolute zero corresponds to a temperature of -237^oC
    d. A temperature interval of 1 K is identical to a temperature interval of 1^oC.

2. If water has a Specific Heat Capacity of 4.9 kJ/kg.K and Mercury has a Specific Heat capacity of 0.14 kJ/kg.K, which statement is ***true***?
    a. It takes a more heat energy to raise the temperature of 0.5kg of mercury by 10^oC than it does to raise the temperature of 0.5kg of water by 10^oC
    b. It takes a less heat energy to raise the temperature of 0.5kg of water by 10^oC than it does to raise the temperature of the same mass of mercury by 10^oC
    c. It takes a less heat energy to raise the temperature of 1kg of mercury by 10^oC than it does to raise the temperature of the same mass of water by 10^oC.
    d. It takes a more heat energy to raise the temperature of 1kg of mercury by 10^oC than it does to raise the temperature of 0.5kg of water by 10^oC

3. The scald from steam is much more painful than the scald from boiling water even though they are both at 100 ^oC because
    a. The high specific heat capacity of water means that molecules of steam have more energy
    b. The high latent heat of fusion of water means that the that molecules of steam have more energy
    c. The high latent heat of vaporisation of water means that the that molecules of steam have more energy
    d. The high latent heat of vaporisation of water means that steam is at higher pressure

4. Kinetic energy is
    a. The energy a body has due to its position
    b. The amount of energy a body loses when it moves
    c. The energy a body has due to the type of bonding between the atoms in that body
    d. The energy a body has due to its motion

5. The Latent Heat is
    a. The amount of energy required to cause a change of state in a substance and increase the temperature of that substance by 1 degree
    b. The amount of energy required to cause a change of state in a substance without increasing the temperature of that substance
    c. The amount of energy required to change the temperature of that substance by 1 degree.
    d. The amount of energy required to cause a change of state in a substance without increasing the temperature of that substance divided by the time.

6. Temperature is NOT
    a. An indication of the average molecular motion in a substance
    b. The potential for heat transfer
    c. An indication of the internal energy of an object
    d. A form of energy

7. A phase change happens
    a. When a change of temperature occurs
    b. Without a change in temperature
    c. When the pressure changes
    d. Without added heat

8. In thermometry it is important that
    a. The thermometer is small and flexible and has high specific heat capacity
    b. The thermometer must have the same specific heat capacity as the substance to be measured.
    c. The thermometer has a linear response
    d. The thermometer and the substance to be measured reach thermal equilibrium

9. If you sit in a high-backed arm chair facing an open fire you feel much warmer than if you sit facing away from the fire in the same chair. Is this because
    a. The predominant method of heat transfer from the open fire is radiation and the back of the chair prevents you from receiving that heat
    b. The predominant method of heat transfer from the open fire is convection and the chair interferes with the convection currents
    c. The predominant method of heat transfer from the open fire is conduction and the chair is a poor conductor
    d. The predominant method of heat transfer from the open fire is convection and the chair cannot conduct heat

10. Which of the following statements is ***false***?
    a. Most materials expand when heated and contract when cooled, water is an exception
    b. Evaporation of water will occur at room temperature because a small proportion of the molecules in the water have enough energy to break free of the liquid as explained by Maxwell Boltzmann's Distribution.
    c. The rate of heat transfer through a slab of material depends only on the temperature of the slab.
    d. When liquid acetone evaporates from your skin, your skin will feel colder due to the latent heat of vaporisation of the acetone.

11. Visible light is composed light of wavelengths in the range
    a. 4.0×10^{-9} m to 7.0×10^{-9} m
    b. 40×10^{-9} m to 70×10^{-9} m
    c. 4.0×10^{-7} m to 7.0×10^{-7} m
    d. 40×10^{-7} m to 70×10^{-7} m

12. Which of the following statements is ***true***?
    a. Dispersion occurs when white light travels through a prism or a water droplet because white light is polychromatic and the different wavelengths of light travel at different speeds in the media
    b. When white light passes through a prism, red light is bent more than blue light because the refractive index of glass is higher for blue light than red light.
    c. The refractive index of glass is lower than the refractive index of air
    d. The separation of white light into its component colours is called diffraction

13. The laws of ***reflection*** state that
    a. The sine of the angle of incidence is equal to the sine of the angle of reflection, and the incident ray, the reflected ray and the normal all lie in the same plane
    b. The sine of the angle of incidence is equal to the sine of the angle of refraction, and the incident ray, the refracted ray and the normal all lie in the same plane
    c. The angle of incidence is equal to the angle of reflection, and the incident ray, the reflected ray and the normal all lie in the same plane
    d. The angle of incidence is equal to the angle of reflection, and the incident ray, the reflected ray and the normal are perpendicular to each other.

14. When the incident angle is less than 90^{o} light refracts when travelling from one medium to another because
    a. Light is polychromatic
    b. The speed of the light changes
    c. Light is coherent
    d. Some light is reflected at the boundary between the two media

15. The critical angle for a glass–air interface is
    a. The incident angle in the glass for which the refracted angle in air is 90^o
    b. The incident angle in the glass for which the refracted angle in the glass is 90^o
    c. The incident angle in the air for which the refracted angle in the air is 90^o
    d. The incident angle in the air for which the refracted angle in the glass is 90^o

16. If light is travelling from one medium into another, and if the second medium has a higher density than the first medium then which statement is ***true***?
    a. the refractive index of the first medium is higher and the light is refracted away from the normal
    b. the refractive index of the first medium is higher and the light is refracted towards the normal
    c. the refractive index of the first medium is lower and the light is refracted away from the normal
    d. the refractive index of the first medium is lower and the light is refracted towards the normal

17. Which statement is ***false***?
    a. A concave lens is a diverging lens
    b. A convex lens can be used as a simple magnifier
    c. A convex lens always forms a real image
    d. Two convex lens can be used in a compound microscope

18. Which statement is ***false***?
    a. Virtual images formed by lenses may be upright or inverted relative to the object
    b. All real images formed with a lens are inverted relative to the object
    c. Concave lenses will only form virtual images
    d. Real images can be seen on a screen at the image position because different light rays from a point on the object meet at the image point.
19. Diffraction is
    a. The result of two or more waves passing though the same region at the same time
    b. The separation of white light into its component colours
    c. Is observed for monochromatic light only
    d. The spreading out of waves as they pass through a gap or around a barrier

20. Which is ***NOT*** a condition for the Young's Double slits experiment?
    a. The screen must be placed a meter away from the slits
    b. The phase difference between the waves remains constant in time
    c. Monochromatic light is needed
    d. The path difference between the waves must not be too great.

Section 2. Answer any 3 questions

Question 1

a) State the factors on which the rate of heat loss through a solid material depends. In each case, state whether a higher value for that factor causes the rate of heat loss to increase or decrease. Hence give the formula for the rate of heat loss. (5 marks)

b) Calculate the rate of heat transfer for a square pane of glass of sides 120 cm and thickness 6 mm, if the inside temperature is 18 ^{0}C and the outside temperature is 9 ^{0}C. (Take the thermal conductivity of for glass as 1.2 W/ m·K.) (5 marks)

c) An oven is in the form of a cube of sides 100 cm. What power must be supplied to maintain it at a temperature of 250 ^{0}C in an environment at 20 ^{0}C? (take e = 0.9) (10 marks)

Question 2

a) Name and explain three methods of heat transfer give examples in each case. (10 marks)

b) Define specific heat capacity. An aluminium pan of mass 200 g is initially at 13 ℃. What mass of water, at an initial temperature of 90 ℃, must be added to produce a final equilibrium temperature of 40 ℃? (Relevant specific heat capacities (in J/kg·℃): water: 4186; aluminium: 900.) (10 marks)

Question 3

a) Use diagrams to demonstrate *Total Internal Reflection* for a glass air interface and calculate the critical angle for light travelling from glass of refractive index 1.54 to air. (8 marks)

b) An object is lying at the bottom of a 2m pool, what is the apparent depth of the object if the refractive index of water is 1.33. Draw a diagram to explain how the concept of apparent depth occurs. (5 marks)

c) Calculate the focal length of the lens made from with glass of refractive index = 1.52 and radii of curvature of 15cm and 20cm (7 marks)

Question 4

a) An object is positioned 10cm in front of a convex lens of focal length 12cm,
   (i) Using graph paper draw a scaled ray diagram to locate the image. (5 marks)
   (ii) What is the nature of this image? (2 marks)
   (iii) Calculate the magnification of the final image. (6 marks)

b) Explain using diagrams how a convex lens is used as a simple magnifier. (7 marks)

Question 5

a) Explain with the aid of sketches how the interference pattern changes if we go from two slits to three to a large number of slits, keeping the slit separation the same. (6 marks)

b) White light is used to illuminate a diffraction grating of 600 lines/mm. An interference pattern is formed on a screen which is 1.5m away. Determine, by calculating the angle at which the spectral lines occur, whether there is overlap between the second order red fringe and the third order violet fringe? (14 marks)

Equation sheet and constants

Stefan Boltzmann constant,

$\sigma = 5.6704 \text{ x} 10^{-8} \text{ W/m}^2 \text{ K}^4$

$$Q = mc\Delta T$$

$$Q = ml$$

$$Q = \frac{kA\Delta Tt}{d}$$

$$H = \frac{kA\Delta T}{d}$$

$$Q = e\sigma AT^4 t$$

$$H = e\sigma AT^4$$

$$H = e\sigma A\left(T_{surface}^4 - T_{\text{environment}}^4\right)$$

$$\Delta l = l_o \alpha \Delta T$$

$$H = \frac{A\Delta T}{R_1 + R_2}$$

$$R = \frac{d}{k}$$

Wavelength of violet light = 400 nm,

Wavelength of red light = 700 nm

Speed of light, c = 3 x 10^8 ms^{-1}

$$n_1 Sin\theta_i = n_2 Sin\theta_r$$

$$\frac{n_1}{n_2} = \frac{\text{Real depth}}{\text{Apparent Depth}}$$

$$\frac{1}{f} = (n-1)\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

$$m = -\frac{v}{u}$$

$$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

$$\mathrm{m}_\theta = \frac{\theta'}{\theta} = \frac{P_n}{u} = \left(\frac{1}{f} - \frac{1}{v}\right)P_n$$

$n\lambda = dSin\theta$

$y = \frac{m\lambda L}{d}$

d = (1/ number of lines per unit length)

Return with answer booklet

Student name _____

Student Number_____

Class group (circle) NHS1 HS1 PB1 S1B

Circle the correct answer

Question 1			
(a)	(b)	(c)	(d)
Question 2			
(a)	(b)	(c)	(d)
Question 3			
(a)	(b)	(c)	(d)
Question 4			
(a)	(b)	(c)	(d)
Question 5			
(a)	(b)	(c)	(d)
Question 6			
(a)	(b)	(c)	(d)
Question 7			
(a)	(b)	(c)	(d)
Question 8			
(a)	(b)	(c)	(d)
Question 9			
(a)	(b)	(c)	(d)
Question 10			
(a)	(b)	(c)	(d)
Question 11			
(a)	(b)	(c)	(d)
Question 12			
(a)	(b)	(c)	(d)
Question 13			
(a)	(b)	(c)	(d)
Question 14			
(a)	(b)	(c)	(d)
Question 15			
(a)	(b)	(c)	(d)
Question 16			
(a)	(b)	(c)	(d)
Question 17			
(a)	(b)	(c)	(d)
Question 18			
(a)	(b)	(c)	(d)
Question 19			
(a)	(b)	(c)	(d)
Question 20			
(a)	(b)	(c)	(d)