UNIVERSITY OF JOHANNESBURG

FACULTY OF SCIENCE

PHYSICS **AUCKLAND PARK KINGSWAY CAMPUS**

PHYG01B

SUPPLEMENTARY EXAMINATION
2 DECEMBER 2014
11:30-14:00

PHYG01B

EXAMINER: **Prof H Winkler**

INTERNAL MODERATOR: Dr E Carleschi

TIME: 2½ HOURS **MARKS: 100**

Please read the following instructions carefully:

ANSWER ALL QUESTIONS: 1-6

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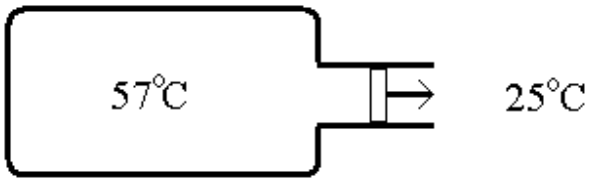
/Question 1

QUESTION 1 **[18]**

a) Define the specific heat capacity. If you give a formula, explain the exact meaning of each of the symbols used. (3)

b) Discuss the ways in which thermal expansion can play a role in the erosion process. (5)

c) A gas at 57°C is sealed at a pressure of 2.00×10^5 Pa inside a large insulated bottle with a heat conducting piston of area 2.50 cm^2, thickness 8.00 mm and k = 12.5 $W.m^{-1}.K^{-1}$. The air outside is at a temperature of 25°C.



The piston moves to the right at 4.00 cm in 1 s while the temperature and pressure remain approximately constant. Calculate the loss in internal energy of the gas during this 1 s. (6)

d) A gas bubble is emitted by an underwater volcano and rises to the ocean surface. Initially the bubble has a volume of 10 cm^3, and the pressure at that depth is 400 kPa. When it reaches the ocean surface, where the pressure is 100 kPa, the bubble's volume is 32 cm^3 and its temperature is 27°C. Determine the gas temperature when the bubble is emitted by the volcano (assume no heat is transferred by conduction in the process). (4)

QUESTION 2 **[16]**

a) Discuss the physics behind the formation and growth of a volcano. (6)

b) Which two factors determine the speed of a sound wave? (2)

c) A standing wave is generated through the interference of two waves moving parallel to the x-axis at 5.00 m/s in opposite directions, both with amplitude 1.20 cm and a wavelength of 1.80 m. Determine the equation describing the y-displacement as a function of x and t. (5)

d) A wave has the equation

$$y = 1.6\cos(180°\,x - 540°\,t + 90°) \quad \text{(angles in degrees)}$$

Determine the velocity of the wave. (3)

QUESTION 3 **[21]**

a) Compare paramagnetism to ferromagnetism. (4)

b) Describe the optical design of a microscope, and explain how this can make small objects appear significantly larger. (5)

c) Order the following in terms of increasing frequency:
i) microwaves, ii) ultraviolet light, iii) yellow light (3)

d) A cylindrical resistor has a length of 16 mm, a radius of 1.20 mm and is made from a material with resistivity $\rho = 675\ \Omega.m$. If a constant electric field of 4.00×10^4 V/m is maintained between the circular ends of the resistor, determine
i) The potential difference across the ends of the resistor;
ii) The current flowing through the resistor. (6)

e) An electron moves into a constant vertical magnetic field $B = 5.0$ T with a speed of 4.0×10^7 m/s. Determine the magnitude of the force acting on the electron if the direction of the electron's motion makes a 53° angle with the horizontal. (3)

QUESTION 4 **[18]**

a) Briefly explain what the solar wind is. (2)

b) Differentiate between alpha and beta radioactive decay. (4)

c) Describe the physical characteristics of:
i) a meteor;
ii) any one of the moons of Jupiter. (6)

d) A star with a surface area of 7.50×10^8 m^2 radiates with a power of 8.40×10^{15} W.
i) How many nuclear reactions take place each second within the star?
ii) What is the surface temperature of the star? (6)

QUESTION 5 **[16]**

a) Name two layers of the atmosphere in which the temperature decreases with height. (2)

b) What is a superior mirage and how is it formed. (5)

c) Explain how wind can generate atmospheric particles, and what role do these play in wind erosion. (5)

d) A beam of blue light at 440 nm enters a clean, aerosol-free atmosphere. Only 70% of the photons in this beam reach the surface (the remainder being scattered in the atmosphere). If another beam of red light at 660 nm enters the atmosphere adjacent and parallel to the blue beam, what percentage of the red light reaches the surface? (4)

QUESTION 6 **[11]**

a) Briefly describe how water salt concentration differences can lead to the formation of ocean currents. (4)

b) How do medium temperature, particle size and viscosity impact on diffusion? (4)

c) You measure the pressure at the water surface and bottom of a lake to be 80 kPa and 620 kPa respectively. Given that the density of water is 10^3 kg/m^3, determine how deep the lake is. (3)

END

Given equations:

$\lambda_{max} = (2.898\times10^{-3}\ \text{m.K})/T$ $\quad$ $\Delta E(2\text{H} + 2\text{n} \rightarrow 1\text{He}) = 4.272\times10^{-12}\ \text{J}$

$E_n = -(2.177\times10^{-18}\ \text{J})/n^2$ $\quad$ $N = N_0 \times \exp(-0.693 \times t/T_{1/2})$

$F_{\text{shear force}} = \eta A \Delta v/\Delta y$ $\quad$ $F_{\text{drag/sphere}} = 6\pi R v \eta$

Constants:

$c = 3\times10^8\ \text{m/s}$ $\quad$ $g = 9.8\ \text{m/s}^2$ $\quad$ $G = 6.67\times10^{-11}\ \text{N.m}^2/\text{kg}^2$ $\quad$ $h = 6.626\times10^{-34}\ \text{J.s}$

$k = 9\times10^9\ \text{N.m}^2/\text{C}^2$ $\quad$ $q_e = -1.6\times10^{-19}\ \text{C}$ $\quad$ $\sigma = 5.67\times10^{-8}\ \text{W.m}^{-2}.\text{K}^{-4}$