



FACULTY OF SCIENCE

PHYSICS

AUCKLAND PARK KINGSWAY CAMPUS

PHYG01B

**EXAMINATION
14 NOVEMBER 2014
8:30-11:00**

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

QUESTION 1**[18]**

- a) Compare on the microscopic level a hot body to a cooler body of the same material. (2)
- b) Define the thermal expansion coefficient α . If you use a formula, define all terms in this expression. (3)
- c) Briefly describe three processes by which heat can be transferred from one body to another. (6)
- d) What term is used to describe water at a temperature below freezing point? (1)
- e) The following two processes are applied to a balloon with 400 g of steam in it initially at 120°C.
- The balloon is placed in contact with a warmer body, resulting in the temperature of the steam rising to 140°C while keeping the volume of the balloon constant. Determine the heat transferred to the steam (the heat capacity of steam is $2010 \text{ J.kg}^{-1}.\text{K}^{-1}$).
 - After this, the volume of the balloon is increased by 0.250 m^3 , while keeping the pressure of the steam constant at 100 kPa. Determine the work done on the steam. (6)

QUESTION 2**[16]**

- a) Use a rough sketch of a transverse wave to illustrate its wavelength. Furthermore explain in words how the speed of the wave is related to the wavelength. (3)
- b) A large earthquake is reported near the boundary of two tectonic plates. Briefly
- describe what caused this earthquake in terms of the physics of the process;
 - explain how the epicentre (exact locality) of the earthquake may be determined using seismology. (7)
- c) The speed of sound of air at 0° is 331 m/s. Calculate the speed of sound in air at a temperature where the air density is 0.90 times the air density at 0°. (3)
- d) A body undergoes simple harmonic motion. The position of the body is determined by the following equation:
- $$y = 4 \sin(5\pi t + \pi/2) \quad [\text{where angles are given in radians}]$$
- Determine the period and frequency of oscillation. (3)

QUESTION 3**[21]**

- a) What process does the Curie point describe, and how can this process aid in the dating of geological formations? (6)
- b) Compare the behaviour of electrons in metals to inside an insulator. (3)
- c) Order the following in terms of increasing wavelength:
- green light,
 - infrared light,
 - x-rays
- (3)

- d) Why does a red shirt look red in the light and black in the dark? (2)
- e) The potential difference across the ends of a $160\text{ k}\Omega$ resistor is 12 V . Calculate the number of electrons passing through it in 1 minute. (4)
- f) An object of height 8.0 mm is placed in front of a lens, forming an image behind the lens. The magnification of the setup is -0.25 . Describe the image. (3)

QUESTION 4**[18]**

- a) Which two fundamental particles form the nucleus of an atom? (2)
- b) How are emission lines generated in the spectrum of a gas? (3)
- c) Distinguish between a planet, a moon and a meteorite. (4)
- d) A cube with sides of 0.10 m radiates at a peak wavelength of $4.00 \times 10^{-6}\text{ m}$.
 i) Calculate the temperature of the cube.
 ii) Determine the power radiated by the cube. (5)
- e) A radioactive sample initially consists of 2.5×10^{16} particles of type A. The radioactive particles of type A decay to type B. 96 hours later the sample contains 8.0×10^{15} particles of type B (with the remainder still type A). What is the half-life of substance A? (4)

QUESTION 5**[16]**

- a) What is ozone and where is the ozone layer? (2)
- b) Explain why an overabundance of greenhouse gases in the atmosphere can lead to global warming. (5)
- c) Briefly explain the formation of a rainbow. (4)
- d) A spherical particle of radius 1.50 mm and density 600 kg/m^3 is suspended in air with a wind speed of 16 m/s relative to the particle. Given that the viscosity of air is $\eta = 2.00 \times 10^{-5}\text{ Pa}\cdot\text{s}$, determine the horizontal acceleration of the particle. (5)

QUESTION 6**[11]**

- a) How do medium temperature, particle size and viscosity impact on diffusion? (4)
- b) A hosepipe has a radius of 5.0 mm , and the water flows through it with a speed of 2.4 cm/s . The water exits the hosepipe through a circular nozzle with a radius of 1.0 mm . With what speed does the water flow through the nozzle? (3)

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c) Calculate the acceleration of a rock with a mass of 250 g and a volume of $1.20 \times 10^{-4} \text{ m}^3$ in water (with density 1000 kg/m^3). (4)

END

Given equations:

$$\lambda_{\max} = (2.898 \times 10^{-3} \text{ m.K})/T$$

$$\Delta E(2\text{H} + 2\text{n} \rightarrow 1\text{He}) = 4.272 \times 10^{-12} \text{ J}$$

$$E_n = -(2.177 \times 10^{-18} \text{ J})/n^2$$

$$N = N_0 \times \exp(-0.693 \times t/T_{1/2})$$

$$F_{\text{shear force}} = \eta A \Delta v / \Delta y$$

$$F_{\text{drag/sphere}} = 6\pi R v \eta$$

Constants:

$$c = 3 \times 10^8 \text{ m/s}$$

$$g = 9.8 \text{ m/s}^2$$

$$G = 6.67 \times 10^{-11} \text{ N.m}^2/\text{kg}^2$$

$$h = 6.626 \times 10^{-34} \text{ J.s}$$

$$k = 9 \times 10^9 \text{ N.m}^2/\text{C}^2$$

$$q_e = -1.6 \times 10^{-19} \text{ C}$$

$$\sigma = 5.67 \times 10^{-8} \text{ W.m}^{-2}.\text{K}^{-4}$$