MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023

PPP0101 PRINCIPLES OF PHYSICS

(Foundation in Information Technology)

5 JULY 2023
9:00 A.M. – 11:00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 6 pages, excluding the cover page.
2. Answer all questions.
3. Write your answers on the answer booklet provided.
4. Show all relevant steps to obtain maximum marks.

QUESTION 1 (10 MARKS)

a) A horizontal force is applied on a block of mass 13.0 kg and is slowly increased. The coefficient of static friction between the block and a horizontal floor, μ_s is 0.77, while the coefficient of kinetic friction, μ_k is 0.54.

(i) Draw a free body diagram for the block. [2 marks]

(ii) Calculate the value of the applied horizontal force at the instant that the block is about to slide. [2 marks]

(iii) Calculate the kinetic friction on the block after it starts to slide. [2 marks]

(iv) Calculate the net force on the block after it starts to slide. [2 marks]

(v) Calculate the magnitude of acceleration of the block after it starts to slide. [2 marks]

QUESTION 2 (10 MARKS)

a) A spring with a spring constant of 65 N/m is attached to a 0.50-kg mass. To form a horizontal mas-spring system, assuming that the amplitude of motion is 3.1 cm, determine

(i) the period of oscillation. [2 marks]

(ii) the maximum velocity. [2 marks]

(iii) the maximum acceleration. [2 marks]

(iv) the total mechanical energy of the system. [2 marks]

b) A mass on a string of unknown length oscillates as a pendulum with a period of 4.0 s. What is the period if

(i) the mass is doubled? [1 mark]

(ii) the length of the string is doubled? [1 mark]

QUESTION 3 (15 MARKS)

a) A radio wave emitted from a source A is given by $y_1 = 6\sin 2\pi(t-x)$, where y_1 and x are in meters, and t is in seconds.

(i) Determine the wavelength and the frequency of the radio wave. [2 marks]

(ii) Calculate the speed of the radio wave. [1 mark]

Continued...

(iii) At the same time, source B generates wave y_2 that is identical to y_1 except that there is a phase difference of $\frac{\pi}{2}$. Write down the wave equation for wave y_2.

[1 mark]

(iv) If y_2 is superimposed to y_1, what is the phase constant and the amplitude of the resultant wave? Write down the equation of the resultant wave.

[4 marks]

b) A standing wave has nodes at $x = 0$ cm, $x = 4.0$ cm, $x = 8$ cm and $x = 12$ cm.

(i) What is the wavelength of the waves that are intefering to produce this standing wave?

[1 mark]

(ii) At what positions are the antinodes? [1 mark]

c) The sound level measured 30 m from a jet plane is about 140 dB. What is its intensity?

[2 marks]

d) Estimate the output power of sound from a person speaking in normal conversation at 65 dB. Assume the sound spreads roughly uniformly over a hemisphere 50 cm in front of the mouth. [3 marks]

QUESTION 4 (15 MARKS)

a) An optical fiber used for communications has a core of refractive index 1.55 which is surrounded by a cladding of refractive index 1.45.

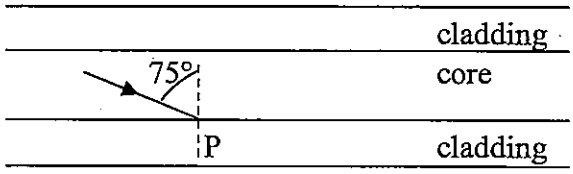

Figure Q5(a)

Figure Q5(a) above shows a light ray inside the core of the fiber strikes the core-cladding boundary at P at an angle of incidence of 75.0°.

(i) Calculate the critical angle of the core-cladding boundary.

[2 marks]

(ii) Will the light ray enter the cladding at P? Briefly explain.

[2 marks]

Continued...

b)

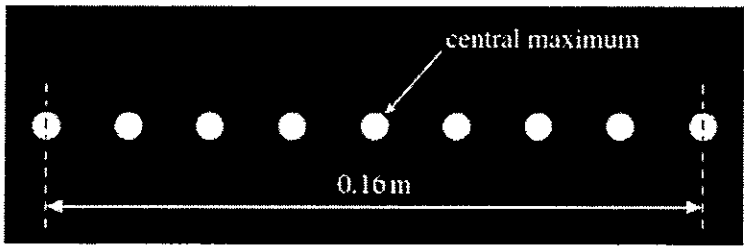

Figure Q5(b)

Figure Q5(b) above shows the maxima of a two-slit interference pattern produced on a screen when a laser was used as a monochromatic light source. The slit spacing is 0.30 mm and the distance from the slits to the screen is 10.0 m. Calculate the wavelength of the light that produced the pattern.

[3 marks]

c)

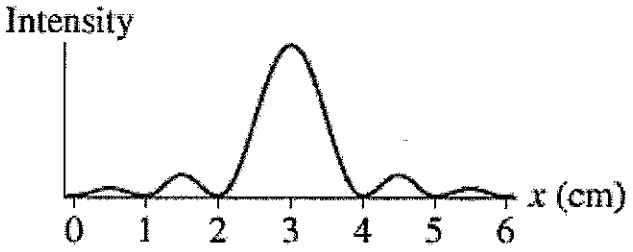

Figure Q5(c)

Figure Q5(c) above shows the light intensity on a screen 2.5 m behind an aperture. The aperture is illuminated with light of wavelength 600 nm.

(i) Is the aperture a single slit or a double slit? [1 mark]

(ii) If the aperture is a single slit, what is its width? If it is a double slit, what is the spacing between the slits? [2 marks]

d) What do you understand by the following?

(i) Law of reflection [1 mark]
(ii) Refraction [1 mark]
(iii) Total internal reflection [1 mark]
(iv) Critical angle [1 mark]
(v) Snell's Law [1 mark]

End of questions.

APPENDIXES

LIST OF PHYSICAL CONSTANTS

Electron mass,	m_e	=	9.11×10^{-31} kg
Proton mass,	m_p	=	1.67×10^{-27} kg
Neutron mass,	m_n	=	1.67×10^{-27} kg
Magnitude of the electron charge,	e	=	1.602×10^{-19} C
Universal gravitational constant,	G	=	6.67×10^{-11} N.m^2 kg^{-2}
Universal gas constant,	R	=	8.314 J/K.mol
Hydrogen ground state,	E_o	=	13.6 eV
Boltzmann's constant,	k_B	=	1.38×10^{-23} J/K
Compton wavelength,	λ_χ	=	2.426×10^{-12} m
Planck's constant,	h	=	6.63×10^{-34} J.s
		=	4.14×10^{-15} eV.s
Speed of light in vacuum,	c	=	3.0×10^8 m/s
Rydberg constant,	R_H	=	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	=	9.81 m s^{-2}
1unified atomic mass unit,	1 u	=	931.5 MeV/c^2
		=	1.66×10^{-27} kg
1 electron volt,	1 eV	=	1.60×10^{-19} J
Avogadro's number,	N_A	=	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing,	I_o	=	1.0×10^{-12} W m^{-2}
Coulomb constant,	$k = \frac{1}{4\pi\varepsilon_o}$	=	9.0×10^9 Nm^2 C^{-2}
Permittivity of free space,	ε_o	=	8.85×10^{-12} C^2/N.m^{-2}
Permeability of free space,	μ_o	=	$4\pi \times 10^{-7}$ (T.m)/A
1 atmosphere pressure,	1 atm	=	1.0×10^5 N/m^2
			1.0×10^5 Pa
Earth: Mass,	M_E	=	5.97×10^{24} kg
Radius (mean),	R_E	=	6.38×10^3 km
Moon: Mass,	M_M	=	7.35×10^{22} kg
Radius (mean),	R_M	=	1.74×10^3 km
Sun: Mass,	M_S	=	1.99×10^{30} kg
Radius (mean),	R_S	=	6.96×10^5 km
Earth-Sun distance (mean),		=	149.6×10^6 km
Earth-Moon distance (mean),		=	384×10^3 km

Continued...

LIST OF FORMULA

Differential Rule

$y = kx^n$

$\frac{dy}{dx} = knx^{n-1}$

Trigonometric Identity

$\sin\theta = \frac{opposite}{hypotenuse}$ $\cos\theta = \frac{adjacent}{hypotenuse}$

$\tan\theta = \frac{opposite}{adjacent}$

$\sin\alpha + \sin\beta = 2\cos\left(\frac{\alpha-\beta}{2}\right)\sin\left(\frac{\alpha+\beta}{2}\right)$

$\sin(\alpha-\beta) + \sin(\alpha+\beta) = 2\sin\alpha\cos\beta$

NEWTONIAN MECHANICS

$v = \frac{\Delta x}{\Delta t}$ $a = \frac{\Delta v}{\Delta t}$ $v = v_o + at$ $x - x_o = v_o t + \frac{1}{2}at^2$

$v^2 = v_o^2 + 2a(x - x_o)$ $x - x_o = \left(\frac{v_o + v}{2}\right)t$

$v = v_o + gt$ $y - y_o = v_o t + \frac{1}{2}gt^2$ $v^2 = v_o^2 + 2g(y - y_o)$ $y - y_o = \left(\frac{v_o + v}{2}\right)t$

$W = Fs\cos\theta$ $W = mg$ $\sum F = F_{net} = ma$ $f_s \le \mu_S F_N$

$f_k = \mu_K F_N$ $K = \frac{1}{2}mv^2$ $PE_s = \frac{1}{2}kx^2$ $F_s = -kx$

$PE_G = mgy$ $T_s = 2\pi\sqrt{\frac{m}{k}}$

Spring with mass, Simple pendulum,

$\omega = \sqrt{\frac{k}{m}}$ $\omega = \sqrt{\frac{g}{l}}$ $T_p = 2\pi\sqrt{\frac{l}{g}}$ $T = \frac{2\pi}{\omega} = \frac{1}{f}$

Cosine Wave:

$x = A\cos\omega t$

$v = -\omega A\sin\omega t$

$a = -\omega^2 A\cos\omega t$

Sine Wave:

$x = A\sin\omega t$

$v = \omega A\cos\omega t$

$a = -\omega^2 A\sin\omega t$

WAVES AND OPTICS

$v = f\lambda$ $\omega = 2\pi f$ $n = \frac{c}{v}$ $n_1\sin\theta_1 = n_2\sin\theta_2$

$\sin\theta_c = \frac{n_2}{n_1}$ $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ $M = -\frac{d_i}{d_o} = \frac{h_i}{h_o}$ $f = \frac{R}{2}$

$d\sin\theta_{max} = m\lambda$ $d\sin\theta_{min} = (m + \frac{1}{2})\lambda$

$y_{bright} = \frac{m\lambda L}{d}$ $y_{dark} = (m + \frac{1}{2})\frac{\lambda L}{d}$ $I = \frac{P}{A}$ $\beta = 10\log_{10}\frac{I}{I_o}$

Continued...

$$f' = f\left(\frac{v \pm v_o}{v \mp v_s}\right) \qquad y(x,t) = A\ \sin(kx \pm \omega t + \phi)$$

Wave Type:

$$y(x,t) = 2A\ \cos\left(\frac{\phi}{2}\right)\ \sin\left(kx - \omega t - \frac{\phi}{2}\right)$$

$$y(x,t) = 2A\ \sin\ kx\ \cos\omega t$$

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