MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER MARCH/APRIL 2024 (TERM ID 2410)

CPP1113 PRINCIPLES OF PHYSICS

(Foundation in Information Technology)

5 JULY 2024
9.00 A.M. – 11.00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 5 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)

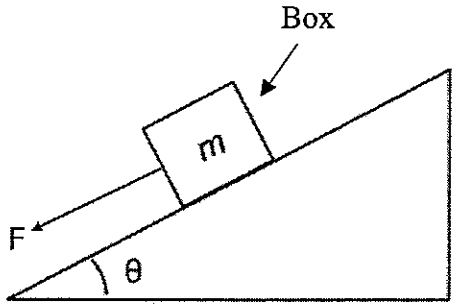

Figure Q1

Based on **Figure Q1** above, assume that m = 0.40 kg , $\mu_k = 0.3$, $\mu_s = 0.5$ and g = 9.8 ms^{-2}. Answer the questions below:

a) If the box is at rest, how large is the friction force exerted on it?

[2 mark]

b) If F = 0 N, determine the minimum angle θ that will cause the box to begin sliding downwards.

[2 mark]

c) If $\theta = 10°$, determine the minimum force F required to start the box in motion.

[3 mark]

d) Calculate the minimum force F to keep the box moving at constant velocity once it has started to move.

[3 mark]

QUESTION 2 (10 MARKS)

a) Dora is exploring the planet Pandora where gravity is slightly less than on Earth. She takes out a pendulum to try to measure this new gravity. The pendulum is small and disc-shaped, and is suspended at the end of a 0.6 m string. She then takes the pendulum at a 12° angle and releases it. After a few swings, she notes that the pendulum takes 0.9 seconds to go from point **A** to point **B** – the farthest points, and another 0.9 seconds to return from point **B** to point **A** as shown in the **Figure Q2** below.

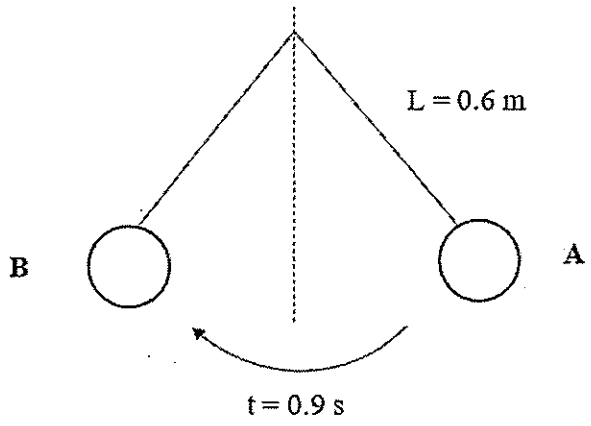

Figure Q2

Continued...

(i) Calculate the gravity of this planet Pandora.

[3 marks]

(ii) How much time would the pendulum need to reach from point A to point B, if the angle of release was increased from 12° to 15°?

[1 mark]

b) The position, x, of a simple harmonic motion (SHM) as a function of time is given by

$$x = 2.4 \cos\left(\frac{4}{3}\pi t\right)$$

where t is in seconds and x is in meters. Find the

(i) spring constant if the mass of the object is 2 kg.

[1 mark]

(ii) period and frequency of the motion.

[2 marks]

(iii) position at $t = 2$ s.

[1 mark]

(iv) velocity at $t = 0.5$ s.

[2 marks]

QUESTION 3 (15 MARKS)

a) Two waves traveling in opposite directions are described by the functions:

$$y_1 = (0.15m)\sin(4.0x - 6.0t)$$
$$y_2 = (0.15m)\sin(4.0x + 6.0t)$$

(where x is in m, t is in s), and they produce a standing wave pattern. Determine the

(i) function of the standing wave.

[0.5 mark]

(ii) resultant amplitude of the standing wave.

[0.5 mark]

(iii) positions of the nodes of the standing wave.

[2.5 marks]

(iv) positions of the antinodes of the standing wave.

[2.5 marks]

b) The power of a sound source is 75 mW.

(i) What is the sound intensity 10 m from the source?

[2 marks]

(ii) If your friend is standing at a distance x from the source, where should you stand so that the sound intensity you hear is one-third of your friend's? Express your answer in terms of x.

[3 marks]

Continued...

c) A bat emits chirping sound of frequency 82.0 kHz while hunting for moths to eat. If the bat is flying towards the moth at a speed of 4.40 m/s and the moth is flying away from the bat at 1.20 m/s, calculate the frequency of the sound wave reflected from the moth as observed by the bat. Assume the speed of sound in air as 343 m/s.

[4 marks]

QUESTION 4 (15 MARKS)

a) Explain the following terms:

(i) Refraction [1 mark]

(ii) Diffraction [1 mark]

(iii) Total Internal Reflection [1 mark]

b) A light enters a glass prism having a refracting angle of 60° as shown in **Figure Q4** below. If the angle of incidence is 30° and the index of refraction of the glass is 1.50, what is the angle the ray leaving the prism makes with the normal?

[5 marks]

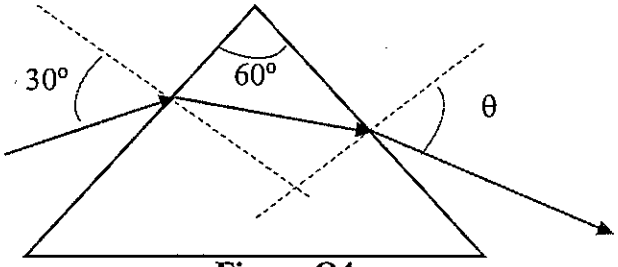

Figure Q4

c) Copy **Table 1** into your answer sheet. State type of interference pattern that can be observe for each experiment. [3 marks]

Experiments	**Interference pattern**
Single slit	
Double slits	
Diffraction gratings	

Table 1

d) A light source emits a mixture of wavelengths from 450 nm and 600 nm. When a diffraction grating is illuminated normally by this source, it is noted that two adjacent spectra barely overlap at an angle of 30°.

(i) What are the order number for both wavelength?

[3 marks]

(ii) How many lines per meter are rules on the grating?

[1 mark]

Continued...

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
Speed of light in vacuum,	c	=	3.0×10^{8} m/s
Acceleration due to gravity,	g	=	9.81 m s^{-2}
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}
Index of Refraction of air,	n_{air}	=	1.0
Index of Refraction of water,	n_{water}	=	1.333

LIST OF FORMULA

Differential Rule

$$y = kx^n$$

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

Trigonometric Identity

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

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

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

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

NEWTONIAN MECHANICS

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

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

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

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

$$PE_G = mgy \qquad T_s = 2\pi\sqrt{\frac{m}{k}} \qquad v = \pm\sqrt{\frac{k}{m}(A^2 - x^2)}$$

Spring with mass, Simple pendulum,

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

Continued...

Cosine Wave:	$x = A\cos\omega t$	Sine Wave:	$x = A\sin\omega t$
	$v = -\omega A\sin\omega t$		$v = \omega A\cos\omega t$
	$a = -\omega^2 A\cos\omega t$		$a = -\omega^2 A\sin\omega t$
	$v_{max} = A\omega$		$a_{max} = A\omega^2$

WAVES AND OPTICS

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

$\sin\theta_c = \frac{n_2}{n_1}$ $\quad d\sin\theta_{max} = m\lambda$ $\quad d\sin\theta_{min} = (m+\frac{1}{2})\lambda$

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

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

Wave Type:

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

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

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