MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

PPP0101 PRINCIPLES OF PHYSICS

(Foundation in Information Technology)

25 OCTOBER 2019
9.00 A.M. – 11.00 A.M.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 8 pages, including the cover page.
2. Answer all questions.
3. Write your answers in the Answer Booklet provided.
4. Show all relevant steps to obtain maximum marks.

QUESTION 1 (10 MARKS)

a) **Figure Q1 (a)** shows the position-versus-time graphs for two objects, A and B, that are moving along the same axis.

(i) At the instant $t = 1$ s, is the speed of A greater than, less than, or equal to the speed of B? Explain.

[1.5 marks]

(ii) Do objects A and B ever have the same speed? If so, at what time or times? Explain.

[1.5 marks]

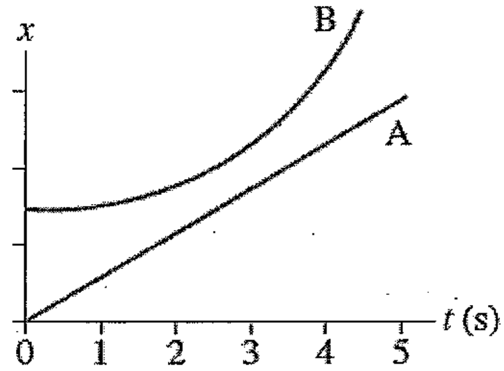

Figure Q1 (a)

b) You're driving down the highway late one night at 20 m/s when a deer steps onto the road 35 m in front of you. Your reaction time before stepping on the breaks is 0.50 s, and the maximum deceleration of your car is 10 m/s^2. How much distance is between you and the deer when you come to a stop?

[3 marks]

c) Ball bearings can be made by letting spherical drops of molten metal fall inside a tall tower and will solidify as they fall.

(i) Immediately after being released, is the magnitude of the drop's acceleration greater than g (gravitational acceleration), less than g, or equal to g? Explain..

[1 mark]

(ii) If a bearing needs 4.0 s to solidify enough for impact, how high must the tower be?

[1.5 marks]

(iii) What is the bearing's impact velocity?

[1.5 marks]

Continued...

QUESTION 2 (10 MARKS)

a) (i) You pull a box with a constant force across a frictionless table using an attached rope held horizontally. If you now pull the rope with the same force at an angle to the horizontal (with the box remaining flat on the table), does the acceleration of the box increase, decrease, or remain the same? Explain.

[1.5 marks]

(ii) Only one force acts on an object. Can the object have zero acceleration? Explain.

[1 mark]

b) Draw the free-body diagram for a basketball player

(i) just before leaving the ground, and

[2 marks]

(ii) while in the air as in **Figure Q2(b)**

[1 mark]

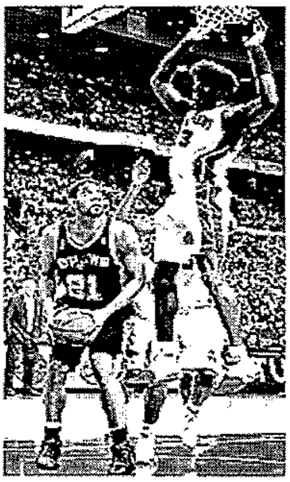

Figure Q2(b)

c) (i) In **Figure Q2(c)**, if $m_A = m_B = 1.00\,\text{kg}$ and $\theta = 33°$, what will be the acceleration of the system? Assume the surface is smooth.

[2.5 marks]

(ii) If $m_A = 1.00\,\text{kg}$ and the system remains at rest, what must the mass m_B be?

[2 marks]

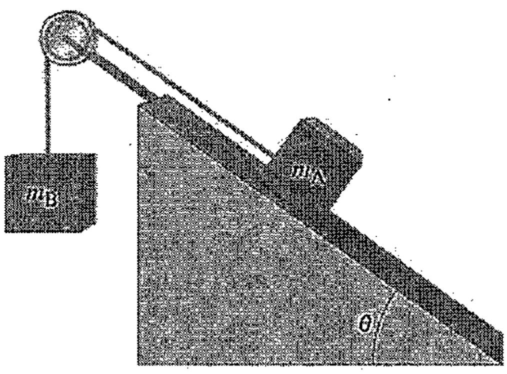

Figure Q2(c)

Continued...

QUESTION 3 (10 MARKS)

A classic children's toy consists of a wooden animal suspended from a spring. If you lift the toy up by 10 cm and let it go, it will gently bob up and down, completing 4 oscillations in 10 seconds.

(i) Describe what an oscillatory motion is.

[1 mark]

(ii) Sketch a sinusoidal graph that shows the toy's position from the equilibrium position for first two cycles of the oscillation.

[3 marks]

(iii) What is the oscillation frequency?

[1.5 marks]

(iv) When does the toy reach its maximum speed, and what is its speed value?

[1.5 marks]

(v) What are the position and velocity at $t = 4.0$ s after you release the toy?

[3 marks]

QUESTION 4 (10 MARKS)

a) A standing wave on a 1.64 m long horizontal string displays three loops when the string vibrates at 120 Hz. The maximum swing of the string (top to bottom) at the center of each loop is 8.00 cm. What is the wave function describing the standing wave?

[5 marks]

b) The sound intensity from a jack hammer breaking concrete is 2.0 W/m^2 at a distance of 2.0 m from the point of impact. This is loud to cause permanent hearing damage if the operator doesn't wear ear protection. If there's a person watching from 50 m away, what are

(i) the sound intensity?

[1.5 marks]

(ii) the sound intensity level?

[1.5 marks]

c) Two automobiles are equipped with the same single-frequency horn. When one is at rest and the other is moving toward the first at 15 m/s, the driver at rest hears a beat frequency of 4.5 Hz. What is the frequency the horns emit? Take the speed of sound is at 343 m/s.

[2 marks]

Continued...

QUESTION 5 (10 MARKS)

a) Can a light ray traveling in air be totally reflected when it strikes a smooth water surface if the incident angle is chosen correctly? Explain.

[1.5 marks]

b) An aquarium filled with water has flat glass sides whose index of refraction is 1.56. A beam of light from outside the aquarium strikes the glass at a 43.5° angle to the perpendicular (Figure Q5(a)). What is the angle of this light ray when it enters

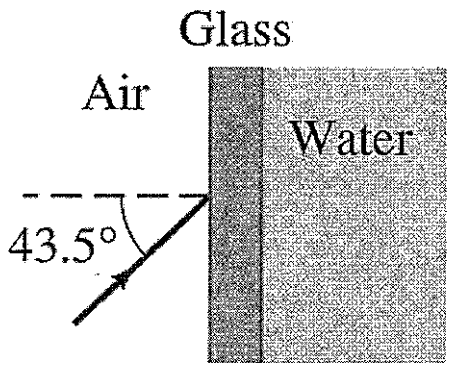

Figure Q5(a)

(i) the glass, and

[1.5 marks]

(ii) the water.

[1.5 marks]

(iii) What would be the refracted angle if the ray entered the water directly?

[1.5 marks]

c) In a double-slits experiment using monochromatic light, the slits are separated by 0.025 mm and a screen is placed 1.25 m. The third-order bright fringe (n = 3) is measured to be 6.60 cm from the center of the central maximum. Find

(i) the wavelength of the light, and

[2 marks]

(ii) the lateral displacement of the second-order bright fringe (n = 2).

[2 marks]

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_c	=	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	Trigonometric Identity
$y = kx^n$ $\frac{dy}{dx} = knx^{n-1}$	$\sin = \frac{opposite}{hypotenuse}$ $\cos = \frac{adjacent}{hypotenuse}$ $\tan = \frac{opposite}{adjacent}$ $\sin\alpha + \sin\beta = 2\cos\left(\frac{\alpha-\beta}{2}\right)\sin\left(\frac{\alpha+\beta}{2}\right)$ $\sin(\alpha-\beta) + \sin(\alpha+\beta) = 2\sin\alpha\cos\beta$

NEWTONIAN MECHANICS

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

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

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

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

$f_k = \mu_K F_N$ $p = mv$ $\sum F = \frac{\Delta p}{\Delta t}$

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ $m_1u_1 + m_2u_2 = (m_1 + m_2)v$ $P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$

$K = \frac{1}{2}mv^2$ $PE_s = \frac{1}{2}kx^2$ $F_s = -kx$ $PE_G = mgy$

$v_{circular} = \frac{2\pi r}{T}$ $a_c = \frac{v^2}{r}$ $F_g = G\frac{m_1m_2}{r^2}$ $U_g = -G\frac{m_1m_2}{r}$

$T^2 = K_s r^3$ $T_s = 2\pi\sqrt{\frac{m}{k}}$

Spring with mass, $\omega = \sqrt{\frac{k}{m}}$

Simple pendulum, $\omega = \sqrt{\frac{g}{l}}$ $T_p = 2\pi\sqrt{\frac{l}{g}}$ $T = \frac{2\pi}{\omega} = \frac{1}{f}$

Cosine Wave: $x = A\cos\omega t$, $v = -\omega A\sin\omega t$, $a = -\omega^2 A\cos\omega t$

Sine Wave: $x = A\sin\omega t$, $v = \omega A\cos\omega t$, $a = -\omega^2 A\sin\omega t$

Continued...

WAVES AND OPTICS

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

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

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

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

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

Wave Type:

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

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

End of paper.