

KATHMANDU UNIVERSITY  
End Semester Examination [C]  
May/June, 2019

Marks Scored:

Level : B.E./B.Sc./B. Pharm./B.Tech.  
Year : I

Course : PHYS 101  
Semester: I

Exam Roll No. : \_\_\_\_\_ Time: 30 mins.

F. M. : 15

Registration No.: \_\_\_\_\_

SDate **02 JUN 2019**

**SECTION "A"**  
[15Q. × 1 = 15 marks]

*Choose and tick the most appropriate answer. The symbols, unless mentioned otherwise, have their usual meanings.*

1. A particle is acted upon by only two forces, one conservative and one nonconservative, as it moves from point A to point B. The kinetic energies of the particle at points A and B are equal if
  - [a] the sum of the works of the two forces is zero.
  - [b] the work of the conservative force is equal to the work of the nonconservative force.
  - [c] the work of the conservative force is zero.
  - [d] the work of the nonconservative force is zero.
  
2. A ball falls to the ground from height  $h$  and bounces to height  $h'$ . Momentum is conserved in the ball-earth system
  - [a] no matter what height  $h'$  it reaches.
  - [b] only if  $h' < h$ .
  - [c] only if  $h' = h$ .
  - [d] only if  $h' > h$ .
  
3. Three particles are placed in the  $xy$  plane. A 30-g particle is located at (3, 4) m, and a 40-g particle is located at (-2, -2) m. Where a 20-g particle must be placed so that the center of mass of the three-particle system is at the origin?
  - [a] (-3, -1) m
  - [b] (+1, +3) m
  - [c] (-1, -3) m
  - [d] (-0.5, -2) m
  
4. An enclosed tank containing a liquid of density  $\rho$  has a hole in its side at a distance  $y_1$  from the tank's bottom (Figure A-1). The hole is open to the atmosphere, and its diameter is much smaller than the diameter of the tank. The air above the liquid is maintained at a pressure  $P$ . The speed at which the liquid leaves the hole when the liquid's level is a distance  $h$  above the hole is given by
 

[a] $v_1 = \sqrt{\frac{2(P-P_0)}{\rho} + 2gh}$	[b] $v_1 = \sqrt{\frac{2(P-P_0)}{\rho} + 2gy_1}$
[c] $v_1 = \sqrt{\frac{2(P+P_0)}{\rho} + 2gh}$	[d] $v_1 = \sqrt{\frac{2(P-P_0)}{\rho} + gh}$
  
5. The moment of inertia of a uniform solid sphere of radius  $R$  and mass  $M$  about an axis tangential to its surface is
 

[a] $\frac{2}{5}MR^2$	[b] $\frac{7}{5}MR^2$	[c] $\frac{5}{7}MR^2$	[d] $\frac{3}{2}MR^2$
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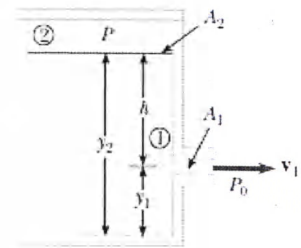






Figure A-1

6. A compound pendulum of length  $l$  and mass  $M$  swings back and forth with period  $T$ . If the mass is doubled, the new time period will be  
 [a]  $\sqrt{2}T$                       [b]  $T$                       [c]  $2T$                       [d]  $\frac{1}{\sqrt{2}}T$
7. According to Hooke's law of elasticity, within proportional limit, if the stress is increased, the ratio of stress to strain  
 [a] increases.                      [b] decreases.                      [c] becomes zero.                      [d] remains constant.
8. Solar cells—devices that generate electricity when exposed to sunlight—are often coated with a transparent, thin film of silicon monoxide (SiO) to minimize reflective losses from the surface. Suppose that a silicon solar cell ( $\mu_2$ ) is coated with a thin film of silicon monoxide ( $\mu_1$ ) for this purpose. When  $\mu_1 < \mu_2$ , the condition for constructive interference for reflected monochromatic light of wavelength  $\lambda$  in air is  
 [a]  $t = m \frac{\lambda}{\mu_1}$                       [b]  $t = \left(m + \frac{1}{2}\right) \frac{\lambda}{\mu_1}$                       [c]  $2t = m \frac{\lambda}{\mu_1}$                       [d]  $2t = \left(m + \frac{1}{2}\right) \frac{\lambda}{\mu_1}$
9. Each pattern shown below would appear on a screen when monochromatic light of wavelength  $\lambda$  first passes through a narrow slit of width ' $a$ ' and then strikes a screen. The darkest areas on the page represent the brightest areas on the screen. In which case does the slit have the greatest width?  
 [a]                       [b]   
 [c]                       [d] 
10. Heat energy from the Sun reaches the earth by  
 [a] scattering.                      [b] conduction.                      [c] radiation.                      [d] convection.

Fill the following blanks with appropriate answers.

11. The reduced mass of hydrogen atom is nearly equal to \_\_\_\_\_
12. The force an ideal spring exerts on an object is given by  $F_x = -kx$ , where  $x$  measures the displacement of the object from its equilibrium ( $x = 0$ ) position. If  $k = 60$  N/m, the work done by this force as the object moves from  $x = -0.20$  m to  $x = 0$  is \_\_\_\_\_
13. In an engine, a piston oscillates with simple harmonic motion so that its position varies according to the expression  $x = (5.00 \text{ cm}) \cos\left(2t + \frac{\pi}{6}\right)$  where  $x$  is in centimeters and  $t$  is in seconds. The velocity (in cm/s) of the body at  $t = 1.0$  s is \_\_\_\_\_
14. When an unpolarized beam of light enters an birefringent material like crystal or quartz, it splits into two plane polarized refracted beams travelling in different directions, one of which always obeys ordinary laws of refraction and the other, in general, does not obey them. This phenomenon is known as \_\_\_\_\_
15. The acronym LASER stand for \_\_\_\_\_

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Course : PHYS 101  
Semester: I  
F. M. : 40

SECTION "B"  
[5Q. × 3 = 15 marks]

1. Define conservative force and Potential energy. Show that the conservative force is a negative gradient of potential energy.
2. A wire of length  $L$ , Young's modulus  $Y$ , and cross-sectional area  $A$  is stretched elastically by an amount  $\Delta L$ . Show that the work done in stretching the wire by an amount  $\Delta L$  is

$$W = \frac{1}{2} YA \frac{(\Delta L)^2}{L}$$

OR

Deduce an expression for the distribution of velocity of a liquid flowing through a uniform capillary tube of circular cross-section. What is the nature of velocity profile?

3. Derive the relation  $M_f = M_0 e^{\frac{v_f}{v_{rel}}}$  for rocket, where symbols have their usual meaning.
4. Unpolarized light traveling in a liquid with refractive index  $\mu$  is incident on the surface of the liquid, above which there is air. If the light incident on the surface at an angle of  $31.2^\circ$  with respect to the normal, the light reflected back into the liquid is completely polarized. (a) What is the refractive index  $\mu$  of the liquid? (b) What angle does the refracted light traveling in air make with the normal to the surface?

OR

Write short notes on: (i) Stimulated absorption, and (ii) Stimulated emission.

5. Figure B-1 shows a composite slab, consisting of two materials having different thicknesses  $L_1$  and  $L_2$  and different thermal conductivities  $k_1$  and  $k_2$ . The temperatures of the outer surfaces of the slab are  $T_H$  and  $T_C$ . Each face of the slab has area  $A$ . Derive an expression for the conduction rate through the slab under the assumption that the transfer is a *steady-state* process.

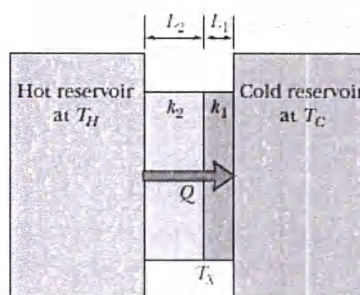


Figure B-1

OR

Explain Planck's hypothesis for black body radiation. Deduce Wein's displacement law from Planck's radiation formula.

**SECTION "C"**  
[5Q × 5 = 25 marks]

6. Establish the differential equation of motion for a damped harmonic oscillator and obtain an expression for displacement. Discuss the case of under damping. Sketch graphs of position versus time for an underdamped oscillator, a critically damped oscillator, and an overdamped oscillator.
7. State and prove the theorem of perpendicular axes for moment of inertia. Find the moment of inertia of a thin uniform rod of length  $L$  and mass  $M$  (i) about an axis passing through the centre of mass and perpendicular to the rod, and (ii) about an axis passing through one end and perpendicular to the rod.

**OR**

Two balls with masses  $M$  and  $m$  are connected by a rigid rod of length  $L$  and negligible mass, as shown in Figure C-1. For an axis perpendicular to the rod, (a) Show that the system has the minimum moment of inertia when the axis passes through the centre of mass. (b)

Show that this moment of inertia is 
$$I = \left( \frac{mM}{m+M} \right) L^2 .$$

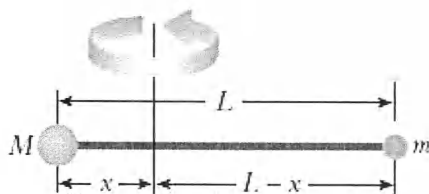


Figure C-1

8. What are coherent sources? Find an expression for fringe-width in case of Young's double slit experiment. Why doesn't the light from the two head lights of a distant car produce an interference pattern?

**OR**

What are Newton's rings and how they are formed? Give, with necessary theory, Newton's rings method for the determination of the wavelength of monochromatic light.

9. Explain Fraunhofer diffraction phenomenon in  $N$ -slits. Derive an expression for intensities ratio of principal and secondary maxima. What will happen if  $N$  is very large?
10. A gas molecule having a speed of 300 meters/sec collides elastically with another molecule of the same mass which is initially at rest. After the collision the first molecule moves at an angle of  $30^\circ$  to its initial direction. Find the speed of each molecule after collision and the angle made with the incident direction by the recoiling target molecule.

**OR**

A 45.36-kg block of ice slides down an incline 1.52 m long and 0.9144 m high. A man pushes up on the ice parallel to the incline so that it slides down at constant speed. The coefficient of friction between the ice and the incline is 0.1. Find (a) the force exerted by the man, (b) the work done by the man on the block, (c) the work done by the gravity on the block, (d) the work done by the surface of the incline on the block, and (e) the change in kinetic energy of the block.