KATHMANDU UNIVERSITY
End Semester Examination [C]
April, 2022

Marks Scored:

Level : B.E.
Year : I
Course : PHYS 101
Semester : I
Exam Roll No. :
Time: 30 mins.
F. M. : 15
Registration no.:
Date :

SECTION "A"
[15Q. × 1 = 15 marks]

Encircle the most appropriate answer. The symbols, unless mentioned otherwise, have their usual

1. The force a spring exerts on a body is a conservative force because
   [a] a spring always exerts a force opposite to the displacement of the body.
   [b] a spring always exerts a force parallel to the displacement of the body.
   [c] the work a spring does on a body is equal for compressions and extensions of equal magnitude.
   [d] the net work a spring does on a body is zero when the body returns to its initial position.

2. A system of three particles of masses 40, 50 and 60 gm has the centre of mass at (2, 2, 2). Where can a fourth particle of mass 70 gm be placed so that the position of new centre of mass will be at (0, 0, 0).
   [a] $\left(-\frac{30}{7},-\frac{30}{7},-\frac{30}{7}\right)$
   [b] $\left(-\frac{30}{7},-\frac{30}{7},\frac{30}{7}\right)$
   [c] $(-30,-30,-30)$
   [d] $(-7,-7,-7)$

3. When the rate of burn and the exhaust velocity are constant, a rocket ascends with
   [a] decreasing acceleration.
   [b] decreasing velocity.
   [c] constant acceleration.
   [d] increasing acceleration.

4. The radius of gyration of a homogeneous circular disc of radius R and mass M about a diameter is
   [a] $\frac{R}{2}$
   [b] $\frac{R}{\sqrt{2}}$
   [c] $\frac{5}{2}R$
   [d] $\frac{1}{\sqrt{2}}R$

5. To double the total energy of a mass oscillating at the end of a spring with amplitude A, we need to
   [a] increase the angular frequency by $\sqrt{2}$.
   [b] increase the amplitude by $\sqrt{2}$.
   [c] increase the amplitude by 2.
   [d] increase the angular frequency by 2.

6. 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.

7. Two slits separated by 0.10 mm are illuminated with green light (λ = 540 nm). Calculate the distance (in cm) from the central bright-region to the fifth bright band if the screen is 1.0 m away.
[a] 2.3 [b] 2.5 [c] 2.7 [d] 2.1

8. When you look through a sheer curtain at a distant street lamp, you see a pattern of colored spots of light. This occurs by
[a] polarization of light in scattering and partial absorption by the threads.
[b] interference of light waves that pass through the threads with light waves that pass through the openings between the threads.
[c] diffraction of light waves passing through the two dimensional pattern of openings between the threads
[d] refraction of light waves differentially in the cylindrical threads.

9. The LASER is a short form of
[a] Light Amplification Stimulated Emission Radiation.
[b] Light Absorption by Stimulated Emission of Radiation.
[c] Light Amplification by Stimulated Emission of Radiation.
[d] Light Amplification by Spontaneous of Emission of Radiation.

10. A metallic slab connects two regions at different temperatures, the rate at which heat flows through the slab is
[a] directly proportional to the thickness of the slab.
[b] directly proportional to the temperature difference.
[c] inversely proportional to the temperature difference.
[d] inversely proportional to the cross-sectional area of the slab.

Fill the following blanks with appropriate answers.

11. The **reduced mass** of hydrogen atom is nearly equal to mass of .....

12. The potential energy function for the force between two atoms in a diatomic molecule can be expressed approximately as follows:

$$U(x) = \frac{a}{x^{12}} - \frac{b}{x^{6}},$$

where a and b are positive constants and x is the distance between atoms.

The force between the atoms is .....

13. A hose has been clamped so that the area at the clamp is only one quarter the area of the rest of the hose. When we ignore the viscosity of water, the ratio of the volume of water delivered per unit time when the clamp is on to the volume of water delivered per unit time without the clamp is ....

14. Sunlight reflected from a smooth ice surface ($\mu_{ice} = 1.31$) is completely polarized. The angle of incidence is .....

15. Heat energy from the Sun reaches the earth by .....

KATHMANDU UNIVERSITY
End Semester Examination [C]
April 2022

Level : B.E.
Year : I
Time : 2 hrs. 30 mins.

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

SECTION "B"
[5Q × 3 = 15 marks]

1. Deduce an expression for the distribution of velocity of a liquid flowing through a uniform capillary tube of circular cross-section.

2. Show that the relative velocity of approach before impact is equal to the relative velocity of separation after impact in an elastic collision in one dimension.

OR

Find the center of mass of a homogeneous semicircular plate of radius R.

3. A wire of length l, Young's modulus Y, and cross-sectional area a is stretched elastically by an amount e. Show that the work done in stretching the wire by an amount e is

$$\boxed{W = \frac{1}{2} Ya \frac{(e)^2}{l}} .$$

4. Explain the terms: spontaneous emission, stimulated emission and population inversion.

OR

Write short notes on: (i) Brewster's Law, and (ii) Specific Rotation

5. The radiation emitted by a star is 10,000 times more than that of the sun. If the surface temperature of the sun and the star are 6000 K and 2000 K respectively, then calculate the ratio of the radii of the star and the sun.

OR

When the temperature of a black body increases, it is observed that the wavelength corresponding to maximum energy changes from 0.26μm to 0.13μm. Calculate the ratio of emissive power of the body at the respective temperature.

SECTION "C"
[5Q × 5 = 25 marks]

6. Establish the differential equation of motion for a forced harmonic oscillator. Solve the equation and find the condition for maximum amplitude (resonance). Discuss the role of damping factor in the resonance.

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

State and prove the perpendicular axes theorem for moment of inertia. Determine the moment of inertia of a solid sphere about a diameter.

8. What is meant by diffraction of light? Show that the intensity distribution for the diffraction in a single slit is given by

$$\boxed{I = I_0 \frac{\sin^2 \alpha}{\alpha^2}} .$$

where the symbols have their usual significance. Deduce the conditions for maxima and minima.

9. What do you mean by coherent sources of light? Obtain an expression for fringe width in case of Young's double slit experiment and show that dark and bright bands are of equal width.

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.

10. A block of mass m = 3.57 kg is drawn at a constant speed a distance d = 4.06 meters along a horizontal floor by rope exerting a constant force of magnitude F = 7.68 N making an angle $\theta = 15°$ with the horizontal. Compute (a) the total work done on the block, (b) the work done by the rope on the block, (c) the work done by the friction on the block, (d) the coefficient of kinetic friction between the block and floor.

OR

A force acting on a particle moving in the xy plane is given by $\vec{F}=(2y\hat{i}+x^2\hat{j})$ N, where x and y are in meters. The particle moves from the origin to a final position having coordinates $x = 5.00$ m and $y = 5.00$ m as shown in Figure C-1. Calculate the work done by $\vec{F}$ on the particle as it moves along OAC, OBC, and OC. Is $\vec{F}$ conservative or nonconservative? Explain.

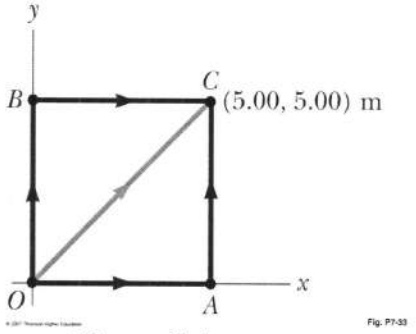

Figure C-1