KATHMANDU UNIVERSITY
End Semester Examination
February/ March 2019

FEB 2 6 2019

Level : B.E./B.Sc./B. Pharm./B. Tech.
Year : I
Time : 2 hrs. 30 mins.

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

SECTION "B"
[5Q. × 3 = 15 marks]

1. What is ballistic pendulum? Explain, how it can be used to measure the velocity of a bullet.

OR

Define conservative force. Show that a conservative force can be expressed as the negative gradient of potential energy.

2. In Young's double-slit experiment, the slits are separated by 0.28 mm and the screen is 1.4 m away. The distance between the central bright fringe and the fourth bright fringe is 1.2 cm. Find the frequency of light used. Use the standard value of velocity of light.

3. What is double refraction? How does it take place in negative and positive crystals? Explain with ray diagram.

OR

What do you mean by spontaneous and stimulated emission? Explain the laser production mechanism with a schematic energy level diagram.

4. State Wien's displacement law and prove it from Planck's radiation law of black body radiation.

5. Assume that Young's modulus for bone is 1.50×10^{10} N/m^2. The bone breaks if stress greater than 1.5×10^{8} N/m^2 is imposed on it. What is the maximum force that can be exerted on the femur bone in the leg if it has a minimum effective diameter of 2.50 cm? If this much force is applied compressively, by how much does the 25.0 cm long bone shorten?

OR

A star rotates with a period of 30 days about an axis through its center. After the star undergoes a supernova explosion, the stellar core, which had a radius 1.0×10^{4} km, collapses into a neutron star of radius 3.0 km. Determine the period of rotation of the neutron star.

SECTION "C"
[5Q. × 5 = 25 marks]

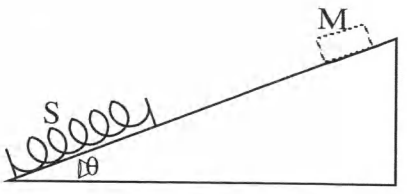
6. Define radius of gyration. Find the moment of inertia of a solid sphere of radius R and uniformly distributed total mass M about (i) a diameter and (iii) a tangent. Also find the radius of gyration of the sphere about the respective axes.

OR

A viscous liquid is flowing across a horizontal tube of radius R and length L as the pressure difference ΔP has been maintained at the two ends. If volume V of the liquid can be collected per second, show that the coefficient of viscosity of the liquid is $\eta = \frac{\pi \Delta P R^4}{8VL}$.

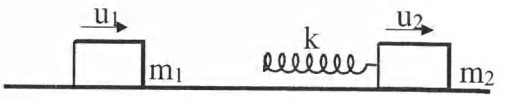
7. Obtain the Newton's second law of motion for the system of variable mass and hence derive the equation of rocket.

8. An ideal spring S can be compressed 1.0 meter by a force of 100 N. This same spring is placed at the bottom of a frictionless inclined plane which makes an angle of $\theta = 30°$ with horizontal as shown in Figure. A 10-kg mass M is released from rest at the top of the inclined plane and is brought to rest momentarily after compressing the spring 2.0 meters. (a) Through what distance does the mass slide before coming to rest? (b) What is the speed of the mass just before it reaches the spring?



OR

A block of mass m_1 = 2.0 kg slides along a frictionless table with a speed of 10 m/s. Directly in front of it, and moving in the same direction, is a block of mass m_2 = 5 kg moving at 3 m/s. A massless spring with a spring constant of k = 1120 N/m is attached to backside of m_2 as shown in figure. When the blocks collide, what is the maximum compression of the spring? Assume that the spring does not bend and always obeys Hook's law.



9. Establish the equation of motion for a damped harmonic oscillation and solve it. Explain the cases of (i) over damping, (ii) critical damping and (iii) under damping.

10. Explain the phenomenon of interference on a thin film of denser medium due to the reflection of light. What would happen if the thin film of rarer medium was made?

OR

Consider a plane wavefront is incident on a system of N-slits with width of opacity a and transparency b. Show that the angle of diffraction for the n^{th} order principal maxima is equal to $\theta_n = \sin^{-1}\left(\frac{n\lambda}{a+b}\right)$, with λ as the wavelength of light used. Also obtain the condition and intensity distribution of secondary maxima.

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SECTION "A"
[15Q. × 1 = 15 marks]

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

1. Which one of the following statements is NOT true?
   [a] Work done by a conservative force is independent of path followed.
   [b] Work done against a conservative is equal to change in potential energy.
   [c] Work done by a non-conservative force is independent of path followed.
   [d] Work done by a non-conservative force is equal to change in mechanical energy.

2. A body is moving along positive x-direction under the application of a force given by $F(x)=\sqrt{a^2-x^2}$ acting along same direction. The work done by the force to move the body from $x=-a$ to $x=+a$ is
   [a] πa^2 [b] $\frac{1}{2}\pi a^2$ [c] $\frac{1}{4}\pi a^2$ [d] 0

3. Two particles are moving with velocities v_1 and v_2 toward same direction with momenta p_1 and p_2 respectively. The velocity of center of mass of the two-particles system is
   [a] $\frac{v_1p_2+v_2p_1}{p_1+p_2}$ [b] $\frac{2v_1v_2}{v_1+v_2}$ [c] $\frac{p_1v_1+p_2v_2}{p_1+p_2}$ [d] $\frac{v_1v_2(p_1+p_2)}{p_1v_2+p_2v_1}$

4. The radius of gyration of a circular disc of radius R about a certain axis perpendicular to the disc is R. The distance of the axis of rotation from the canter of the disc is
   [a] $\frac{1}{2}R$ [b] $\frac{1}{\sqrt{2}}R$ [c] $\frac{1}{4}R$ [d] $\frac{\sqrt{3}}{2}R$

5. A body of mass m_1 is gently dropped on an ideal spring placed vertically upward. The spring is compressed to a distance d. If another body of mass m_2 is abruptly dropped and stick to the mass m_1, then the system will oscillate with the time period of
   [a] $T=2\pi\sqrt{\frac{(m_1+m_2)d}{m_1g}}$ [b] $T=2\pi\sqrt{\frac{m_2d}{m_1g}}$
   [c] $T=2\pi\sqrt{\frac{m_2d}{(m_1+m_2)g}}$ [d] $T=2\pi\sqrt{\frac{d}{g}}$

6. An ideal liquid is allowed to flow across two tube of internal radii R_1 and R_2 connected in series. If v_1 and v_2 are the respective velocities on the tubes, then

[a] $\frac{v_1}{v_2}=\frac{R_1}{R_2}$ [b] $\frac{v_1}{v_2}=\frac{R_2}{R_1}$ [c] $\frac{v_1}{v_2}=\frac{R_2^2}{R_1^2}$ [d] $\frac{v_1}{v_2}=\frac{R_1^2}{R_2^2}$

7. A thin film of thickness t of refractive index μ_1 coats a surface with refractive index μ_2. When $\mu_1 < \mu_2$, the condition for constructive interference for reflected monochromatic light of wavelength λ in air is (assuming normal incidence and $n = 0, 1, 2, \cdots$)

[a] $\mu_1 t = n\lambda$ [b] $2\mu_1 t = (2n+1)\lambda$

[c] $2\mu_1 t = n\lambda$ [d] $4\mu_1 t = (2n+1)\lambda$

8. Three waves each of amplitude 3 units have same frequencies and successively increased phases. The phase difference between first and second wave is 60°and that of between first and third is 120°. When the three waves superposed, the resultant amplitude will be

[a] 6 units [b] 3 units [c] 9 units [d] $2\sqrt{3}$ units

9. The specific rotation of a liquid is independent of the

[a] nature of the liquid. [b] wavelength of light used.

[c] temperature of the liquid. [d] length and concentration of the liquid.

10. The coefficient of thermal conductivity of cylindrical disc depends on

[a] thickness of the disc. [b] cross-section area of the disc.

[c] nature of the material of the disc. [d] temperature difference across the disc.

Fill the following blanks with appropriate answers.

11. A 1-meter radius sphere is used as a compound pendulum. The length of a simple pendulum whose time period is equal to the minimum time period of the compound pendulum is .....

12. The material whose fracture point lies very close to the yield point in its stress-strain graph is called .....

13. The maximum number of lines per inch in a grating such that only first order principal maxima can be observed for the wavelength of 589 nm is .....

14. The Polaroid crystal in which Ordinary rays travel faster than Extra-ordinary rays is called .....

15. A state on a laser device in which there is longer life time for staying the electrons is called .....