

KATHMANDU UNIVERSITY  
End Semester Examination [C]  
June/July 2024

Marks Scored:
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Level : B.Sc./B.Tech  
Year : I

Course : PHYS 104  
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date : 04 JUL 2024

SECTION "A"  
[20Q. × 1 = 20 marks]

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

1. An ideal spring exerts the force on an object given by  $F_x = -kx$ , where  $x$  measures the displacement of the object from its equilibrium ( $x = 0$ ) position. If  $k = 60$  N/m, then work done by this force as the object moves from  $x = -0.2$  m to  $x = 0$  is  
 a.  $-1.2$  J                      b.  $1.2$  J                      c.  $-2.4$  J                      d.  $2.4$  J
2. A 4 kg particle is moving horizontally at a speed of 5 m/s when it strikes a vertical wall. After the collision, the particle rebounds with a speed of 3 m/s. The magnitude of the impulse delivered to the particle is  
 a.  $16$  N.s                      b.  $24$  N.s                      c.  $32$  N.s                      d.  $40$  N.s
3. In an inelastic collision, the kinetic energy after collision  
 a. is same as before collision  
 b. is always less than that before collision  
 c. is always greater than that before collision  
 d. may be less than or greater than that before collision
4. In the absence of any external force, the velocity of center of mass is  
 a. zero                      b. constant                      c. increases                      d. decreases
5. The moment of inertia of a circular ring of mass  $M$  and radius  $R$  about its diameter is  
 a.  $MR^2$                       b.  $2MR^2$                       c.  $\frac{1}{2}MR^2$                       d.  $\frac{3}{2}MR^2$
6. A particle moves such that its acceleration  $a$  is given by  $a = -bx$ , where  $x$  is displacement from equilibrium position and  $b$  is a constant. The period of oscillation is  
 a.  $2\pi\sqrt{b}$                       b.  $\frac{2\pi}{\sqrt{b}}$                       c.  $\frac{2\pi}{\sqrt{a}}$                       d.  $\frac{2\pi}{b}$
7. When the liquid layers are in relative motion, a force begins to act. This force is called  
 a. Viscous force and acts tangential to the layers  
 b. Viscous force and acts normal to the layers  
 c. Surface tension force and acts normal to the layers  
 d. Elastic force and acts tangential to the layers
8. The differential equation of simple harmonic motion is given by  $\frac{d^2x}{dt^2} + 100x = 0$ . The frequency of motion is  
 a. 1                      b. 10                      c.  $\frac{10}{2\pi}$                       d.  $\frac{100}{2\pi}$

9. In an isothermal process  
 a. pressure remains constant  
 b. volume remains constant  
 c. temperature remains constant  
 d. kinetic energy remains constant
10. "Heat cannot by itself flow from a body at lower temperature to a body at higher temperature" is a statement or consequence of  
 a. second law of thermodynamics  
 b. first law of thermodynamics  
 c. conservation of momentum  
 d. conservation of mass
11. X-rays passing through a strong uniform magnetic field  
 a. get deflected along the direction of field  
 b. get deflected opposite to the direction of field.  
 c. get deflected perpendicular to the direction of field  
 d. do not get deflected at all
12. When a radioactive nucleus emits a  $\beta$  - particle, the mass number of the atom  
 a. remains the same  
 b. decreases by one  
 c. increases by one  
 d. decreases by four
13. Four rods of same metal but of different radii and lengths are used to connect two reservoirs of heat at different temperatures. Which one of the following will conduct most heat?  
 a.  $r = 1$  cm and  $\ell = 0.5$  m  
 b.  $r = 2$  cm and  $\ell = 0.5$  m  
 c.  $r = 1$  cm and  $\ell = 1$  m  
 d.  $r = 2$  cm and  $\ell = 2$  m
14. Two coherent sources are 0.18 mm apart and the fringes are observed on a screen 80 cm away. It is found that with a monochromatic source of light, the fourth bright fringe is situated at a distance of 10.8 mm from the central fringe. The wavelength of light used is  
 a.  $6.075 \times 10^{-5}$  cm  
 b.  $60.75 \times 10^{-7}$  cm  
 c.  $6.075 \times 10^{-6}$  cm  
 d.  $0.6075 \times 10^{-8}$  cm
15. A half-wave plate is fabricated for a wavelength of 3800 Å. For what wavelength does it work as a quarter-wave plate?  
 a. 6000Å  
 b. 6500Å  
 c. 7000Å  
 d. 7600Å

**Fill the following blanks with appropriate answers.**

16. The splitting of heavy nucleus into two or more fragments of comparable masses, with an enormous release of energy is called \_\_\_\_\_
17. In a pipe, if the Reynold's number is less than 2000, then the flow is \_\_\_\_\_
18. The diffraction phenomenon in which source and screen both are separated by the infinite distance from slit is called \_\_\_\_\_
19. When a specimen is placed in a magnetic field and is then cooled through the transition temperature for superconductivity, the magnetic flux originally present is ejected from the specimen. This phenomenon is called \_\_\_\_\_
20. An un-polarized beam of intensity  $I_0$  watt/m<sup>2</sup> is incident on a pair of Nicols prism making an angle 60° with each other. The intensity of light emerging from the pair is \_\_\_\_\_

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

04 JUL 2024

Course : PHYS 104  
Semester : I  
F. M. : 55

SECTION "B"

[5 Q × 4 = 20 marks]

Attempt ALL questions.

1. State and prove work energy theorem by constant and variable forces.
2. The force  $F_x$  acting on a particle varies as shown in Figure 1B. Find the work done by the force as the particle moves from  $x_i = 0$  to  $x_f = 10$  m.

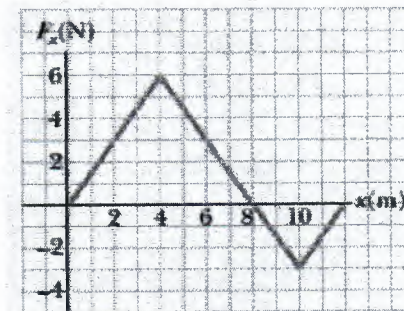


Figure 1B: Plot of Force- distance

OR

A bar of length 40 cm and uniform cross-section  $5 \text{ cm}^2$  consists of two halves, AB of copper and BC of iron welded together at B. The end A is maintained at  $200^\circ\text{C}$  and end C at  $0^\circ\text{C}$  and the sides are thermally insulated. Find the rate of flow of heat along the bar when the steady state has been reached. (Given: Thermal conductivities of Copper and Iron are 0.9 and 0.12 respectively).

3. What is ballistic pendulum? Describe how it can be used to calculate the initial velocity of bullet.
4. Enunciate the first law and second law of thermodynamics. Prove thermodynamically that  $C_p - C_v = R$  for a perfect gas where the terms have their usual meanings.

OR

State the law of radioactive decay. Deduce the relation  $N = N_0 e^{-\lambda t}$ , where symbols have their usual meanings. Sketch a graph to illustrate radioactive decay.

5. Locate the centre of mass of semi-circular plate of radius  $R$ .

OR

Calculate the energy released in the fission of 500 gm of  $^{235}\text{U}$  in terms of kWh. Assume that the disintegration energy per event is 208 MeV. (Given: Avogadro's number  $= 6.02 \times 10^{23} \text{ mole}^{-1}$ )

**SECTION "C"**  
[5 Q × 7 = 35 marks]

Attempt ALL questions.

6. Why do gases have two values of specific heat? Also, explain why the specific heat at constant pressure  $C_P$  is greater than that of the specific heat at constant volume  $C_V$ . On the basis of the first law of thermodynamics, prove the relation  $C_P - C_V = R$ .
7. Define rotational inertia and radius of gyration. Calculate the rotational inertia of a solid sphere of radius  $R$  and total mass  $M$  about a diameter.

**OR**

Distinguish between laminar and turbulent flow of fluid. Deduce an expression for the distribution of velocity of the fluid flowing through a capillary tube of radius  $R$  and length  $L$ .

8. Establish the differential equation of compound pendulum and obtain its time period. Show that point of suspension and point of oscillation are interchangeable. Also find the minimum time period.
9. What do you mean by interference of light? Mention the conditions under which the phenomenon of interference can occur. Prove that the fringe width  $\beta$  between two successive bright and dark fringes formed in Young's double slit experiment is given by  $\beta = \frac{D\lambda}{d}$ .

**OR**

Explain the phenomenon of double refraction in calcite crystal. Describe how Nicol prism acts as a polarizer and analyzer.

10. Explain how Carnot's cycle is reversible. Derive an expression for its efficiency and hence establish the relation  $\frac{T_2}{T_1} = \frac{Q_2}{Q_1}$ .

**OR**

What do you mean by Raman effect? Give the quantum mechanical explanation of it. Write three characteristics of Raman effect.

11. A plane diffraction grating has 15000 lines per inch. Find the angular separation of the 5048Å and 5016Å lines of helium in the second order spectrum.

**OR**

A block of mass  $m_1 = 2$  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 below. When the blocks collide, what is the maximum compression of the spring? Assume that spring does not bend and always obeys Hooke's law.

