KATHMANDU UNIVERSITY
End Semester Examination
June/July, 2023

Marks Scored:

Level : B.Sc./B.Tech.
Year : I
Course : PHYS 104
Semester: I

Exam. Roll No. :
Time: 30 mins.
F.M. : 20

Registration No.:
Date : 03 JUL 2023

SECTION "A"
[20Q × 1 = 20 marks]

Encircle the most appropriate alternative from each set of choices.

1. Work done by non-conservative force is equal to
   a. change in kinetic energy
   b. change in potential energy
   c. change in mechanical energy
   d. change in total energy

2. A 6 kg block initially at rest is pulled to the right along a frictionless, horizontal surface by a constant horizontal force of magnitude 12 N. The block's speed after it has moved through a horizontal distance of 3 m is
   a. 3.5 m/s
   b. 8.2 m/s
   c. 12 m/s
   d. 36.2 m/s

3. The center of mass of the system consists of three particles of masses $m_1 = 1\,\text{kg}$, $m_2 = 1\,\text{kg}$ and $m_3 = 2\,\text{kg}$ located as shown in Figure 1 is
   a. $(1, 0.75)\,\text{m}$
   b. $(0.75, 1)\,\text{m}$
   c. $(7.5, 1)\,\text{m}$
   d. $(1, 7.5)\,\text{m}$

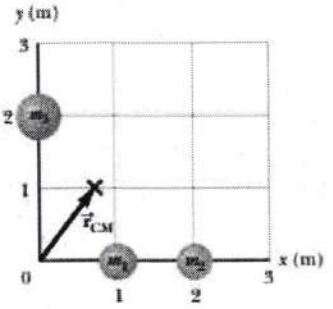

Figure 1:
Distribution of point masses in a plane

4. A rocket is fired vertically upward. At the instant it reaches an altitude of 1000 m and a speed of $v_i = 300\,\text{m/s}$, it explodes into three fragments having equal mass. One fragment moves upward with a speed of $v_1 = 450\,\text{m/s}$ following the explosion. The second fragment has a speed of $v_2 = 240\,\text{m/s}$ and is moving east right after the explosion. The velocity of the third fragment immediately after the explosion is
   a. 210 m/s
   b. 475 m/s
   c. 620 m/s
   d. 900 m/s

5. In damped vibration of an oscillator, the amplitude goes on
   a. increasing exponentially
   b. decreasing exponentially
   c. decreasing linearly
   d. remains constant

6. A fluid flows through a tube of circular cross-section, which varies from point to point, but the flow is steady. If v is the velocity of the fluid at a point, where the radius of curvature of tube is R, then at a different points along the length of tube
   a. $\frac{v}{R} = \text{constant}$
   b. $vR = \text{constant}$
   c. $vR^2 = \text{constant}$
   d. $v^2R = \text{constant}$

7. A spherical solid ball of mass 1 kg and radius 3 cm is rotating about an axis passing through its centre with an angular velocity of 50 rad/s. The kinetic energy of rotation is
a. 0.45 J b. 1.125 J c. 90 J d. 4500 J

8. In a radioactive decay neither the atomic number nor the mass number changes which of the following would be emitted in the decay process?
a. electron b. proton c. neutron d. photon

1. A thermodynamic system, initially at absolute temperature T_1, contains a mass m of water with specific heat capacity c. Heat added until the temperature rises to T_2. The change in entropy of water is

a. $T_2 - T_1$ b. mcT_2 c. $mc(T_2 - T_1)$ d. $mc \ln\left(\frac{T_2}{T_1}\right)$

2. Which of the following thermodynamic process is correct for given PV indicator diagram as shown in Figure 2?
a. Isochoric process
b. isothermal process
c. adiabatic process
d. isobaric process

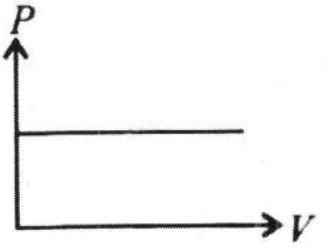

Figure 2: PV indicator diagram

11. The given nuclear reaction ${}_1H^2 + {}_1H^2 \rightarrow {}_2He^4 + Q$ is a
a. nuclear fission reaction b. nuclear fusion reaction
b. spontaneous reaction d. reversible reaction

12. From the Figure 3, it can be concluded that, phase change of
a. $\frac{\pi}{2}$ occurs between AB and BE
b. π occurs between AB and BE
c. π occurs between AB and BC
d. π occurs between BC and CD

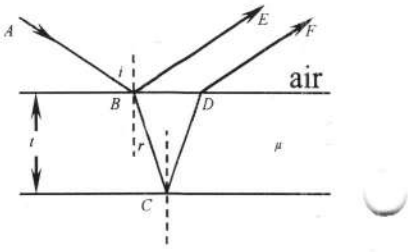

Figure 3

13. "The product of wavelength corresponding to maximum energy and the absolute temperature is constant". This is the statement for
a. Wien's law b. Planck's law
c. Rayleigh-Jean's law d. Stefan-Boltzmann law

14. What is the highest order spectrum, which may be seen with monochromatic light of wavelength 5700 Å by means of a diffraction grating with 2500 lines per cm?
a. 1 b. 3 c. 5 d. 7

15. A ray of light is incident on the surface of glass plate at an angle of incidence equal to Brewster's angle θ. If μ represents the refractive index of glass with respect to air, then the angle between the reflected and refracted rays is
a. $90^o + \theta$ b. $90^o - \theta$ c. 90^o d. $90^o + 2\theta$

Fill in the blanks with most appropriate answer:

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16. The distance between the centre of suspension and centre of oscillation of a compound pendulum is equal to .....

17. The plane perpendicular to the plane of vibration and containing the direction of propagation of light is called.....

18. If a Carnot engine is operating between 100°C and 50°C. Its efficiency in percentage (%) will be .....

19. The ballistic pendulum is an apparatus used to measure the speed of a fast moving projectile such as a bullet. A projectile of mass m_1 is fired into a large wooden block of mass m_2 suspended by light strings. The projectile embeds into the block, and the entire system swings through a height h. The speed of the system which causes to attain the maximum height h is.....

20. The X-ray produced by the transition of electrons from M-shell to K-shell is called.....

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SECTION "B"
[5Q. × 4 = 20 marks]

1. Define conservative force. Show that the resultant of conservative forces is equal to the negative gradient of potential energy.

2. Two identical solid spheres of radius R mass M are joined together, and the combination is rotated about an axis tangent to one sphere and perpendicular to the line connecting them as shown in Figure 1. What is the rotational inertia of the combination about the axis?

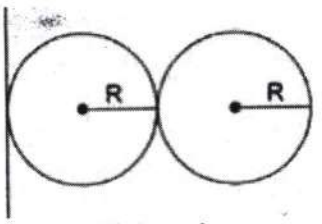

Figure 1

OR

Find the peak wavelength of the blackbody radiation emitted by (a) the human body when the skin temperature is 35°C and (b) the Sun, which has a surface temperature of approximately 5800 K.

3. Distinguish between Fresnel and Fraunhoffer types of diffraction. Obtain the resultant amplitude of n waves with same amplitude and frequencies.

4. What do you mean by collision? Prove that in one-dimensional elastic collision, the relative velocity of approach before collision is equal to the relative velocity of separation after collision.

OR

Define isothermal process. Show that work done during isothermal process is $W = nRT \ln\left(\frac{P_1}{P_2}\right)$. Sketch the PV diagram to illustrate this process.

5. What do you mean by radiation hazard? What are the precautions to be made against the radiation hazard? Discuss various uses of nuclear radiation.

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.

SECTION "C"

[5Q × 7 = 35 Marks]

6. Define centre of mass for the system of particles distributed in space. What happen to the first moment of mass for the system when the centre of mass coincides with the origin of the coordinate system? Show that the centre of mass moves with constant velocity when the resultant external force acting on the system is zero.

OR

Define compound pendulum and obtain its time period. Show that the point of suspension and point of oscillation are interchangeable. Also calculate minimum time period.

7. Obtain equation of continuity for the flow of an ideal fluid flowing through a pipe. State and prove Bernoulli's theorem for non-viscous and incompressible flow of fluid.

8. Obtain an expression for intensity distribution in interference. Prove that the fringe width β between two successive bright fringes or dark fringes formed in Young's double slit experiment is $D\lambda / d$.

OR

Give the construction and theory of half wave and quarter wave plates. State and prove Malus law.

9. Explain how Carnot's cycle is reversible. Show that the efficiency of Carnot cycle depends upon the temperature of source and the sink and is independent of the nature of working substance.

OR

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

10. A gas molecule having a speed of 300 m/s collides elastically with another molecule of the same mass which is initially at rest. After collision the first molecule moves at an angle of 30° 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 typical nuclear fission power plant produces approximately 1 GW of electric power. Assume the plant has an overall efficiency of 40 % and each fission reaction produces 200 MeV of energy. Calculate the mass of ^{235}U consumed each day. (Given: Avogadro's number $N = 6.025 \times 10^{26}$)