

KATHMANDU UNIVERSITY
End Semester Examination [C]
December, 2024

Marks Scored:

Level : B.Pharm

Course : PHYS 104

Year : I

Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date

16 DEC 2024

SECTION "A"

[20Q. \times 1 = 20 marks]

Choose and encircle in the most appropriate option from each set of choices

- Work done by non-conservative force is equal to
 - change in kinetic energy
 - change in mechanical energy
 - change in potential energy
 - change in total energy
- A 5 kg block initially at rest is pulled to the right along a frictionless, horizontal surface by a constant horizontal force of magnitude 10 N. The block's speed after it has moved through a horizontal distance of 2 m is
 - 2 ms^{-1}
 - 3 ms^{-1}
 - 4 ms^{-1}
 - 5 ms^{-1}
- A body of mass m having an initial velocity v , makes head on collision with a stationary body of mass M . After collision the body of mass m comes to rest and the body of mass M moves. This will happen only when
 - $m = M$
 - $m = M / 2$
 - $m \gg M$
 - $m \ll M$
- The centre of mass of a body
 - lies always outside the body
 - lies always inside the body
 - lies always on the surface of the body
 - may be within, outside or on the surface of the body
- A stone of mass 5 kg is whirled in a horizontal circle of radius 0.5 m and makes 2 rev/sec. The moment of inertia of stone about its axis of rotation is
 - 1.25 kg.m^2
 - 2.5 kg.m^2
 - 5 kg.m^2
 - 10 kg.m^2
- Two springs 1 and 2 have force constants k_1 and k_2 respectively, where $k_1 > k_2$. Which of the following is true about the extensions Δx_1 and Δx_2 of the two springs if same external force is applied to both springs?
 - $\Delta x_1 < \Delta x_2$
 - $\Delta x_1 > \Delta x_2$
 - $\Delta x_1 \geq \Delta x_2$
 - $\Delta x_1 \leq \Delta x_2$
- Bernoulli's theorem is based on
 - conservation of momentum
 - conservation of energy
 - conservation of mass
 - conservation of charge
- According to First law of Thermodynamics, which of the following relation is **TRUE**?
 - $\Delta Q = \Delta U + \Delta W$
 - $\Delta Q = \Delta U - \Delta W$
 - $\Delta U = \Delta Q + \Delta W$
 - $\Delta W = \Delta Q + \Delta U$

9. During reversible process, the entropy remains
 a. unity b. infinity c. constant d. increases
10. X-rays can be used
 a. for boring, cutting and welding with precision
 b. detecting fractures in bones
 c. to detect heavy elements under the earth
 d. for retina stitching in eye operation
11. The minimum time period of compound pendulum is
 a. $T_{\min} = \sqrt{2\pi \frac{2k}{g}}$ b. $T_{\min} = \pi \sqrt{\frac{2k}{g}}$ c. $T_{\min} = 2\pi \sqrt{\frac{k}{g}}$ d. $T_{\min} = \pi \sqrt{\frac{8k}{g}}$
12. If 'a' is the width of the slits and 'b' the distance between the slits, then 'a + b' is called as
 a. opacities b. transparency c. grating element d. wavelength
13. The relationship between decay constant λ and half-life $T_{1/2}$ of the radioactive substance is
 a. $T_{1/2} = \frac{0.693}{\lambda}$ b. $T_{1/2} = \frac{0.793}{\lambda}$ c. $T_{1/2} = \frac{0.893}{\lambda}$ d. $T_{1/2} = \frac{0.993}{\lambda}$
14. What type of nuclear reaction is responsible for liberation of energy in the nuclear reactor?
 a. nuclear fusion b. nuclear fission
 c. nuclear destruction d. atomic energy
15. A beam of light strikes a piece of glass at an angle of incidence 60° . It is found that the reflected beam is completely plane polarized. Then refractive index of glass is
 a. 1.55 b. 1.60 c. 1.65 d. 1.73

Fill in the blanks with most appropriate answer:

16. A bullet of mass A and velocity B is fired into a block of mass C and sticks to it. The final velocity of system equals to _____.
17. The differential equation of damped harmonic oscillator is _____.
18. The phenomenon of getting dark and bright fringes due to superposition of two coherent light sources is called _____.
19. The thermodynamic process in which there is no exchange of heat between the system and surrounding is called _____.
20. The minimum kinetic energy of the incoming particle needed to initiate the nuclear reaction 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. A parallel beam of monochromatic light is allowed to be incident normally on a plane grating having 1250 lines per cm and a second order spectral line is observed to be deviated through 30° . Calculate the wavelength of the spectral line.

OR

- A 0.05 kg ingot of metal is heated to 200°C and then dropped into a calorimeter containing 0.4 kg of water initially at 20°C . The final equilibrium temperature of the mixed system is 22.4°C . Find the specific heat of the metal. Specific heat capacity of water $4200\text{ J kg}^{-1}\text{ }^\circ\text{C}^{-1}$.
3. What is a half-wave plate? Deduce its thickness for a given wavelength in terms of its refractive indices.
 4. Deduce Wein's displacement law from Plank's radiation formula

$$E_\lambda d\lambda = \frac{8\pi hc}{\lambda^5} \frac{1}{e^{hc/\lambda kT} - 1} d\lambda$$

OR

- Explain the concept of entropy and disorder. Show that the entropy remains constant during reversible process.
5. 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.

OR

Calculate the binding energy per nucleon of ${}_{26}\text{Fe}^{56}$. [Given: Atomic mass of ${}_{26}\text{Fe}^{56}$ is 55.9349u and that of ${}_1\text{H}^1$ (or proton) is 1.00783u and mass of ${}_0n^1$ is 1.00867u and $1\text{u} = 931\text{MeV}$]

P.T.O.

SECTION "C"
[5Q × 7 = 35 marks]

6. Derive Newton's second law for the system of variable mass and hence prove the relation $M_f = M_0 e^{-\frac{v_f}{v_{rel}}}$ for rocket, where symbols have their usual meaning.

OR

Define centre of mass for the system of particles distributed in space. What happens 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.

7. Establish the differential equation of mass loaded horizontal spring and solve it. Obtain its time period and frequency. Show that total energy $E = K_{\max} = U_{\max} = \frac{1}{2}kA^2$.

OR

Obtain the kinetic energy of rotation and rotational inertia. Determine the rotational inertia of a uniform slender rod of length L about an axis through its center of mass and its one end.

8. Explain superposition of waves and interference of light. Show that the ratio of maximum to minimum intensity is $\frac{I_{\max}}{I_{\min}} = \frac{(\sqrt{I_1} + \sqrt{I_2})^2}{(\sqrt{I_1} - \sqrt{I_2})^2}$. Also show that the intensity of each bright fringe is same and same is true for dark fringes. Plot the intensity distribution curve.

OR

Why do gases have two values of specific heats? 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 first law of thermodynamics, prove the relation $C_p - C_v = R$.

9. 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.

OR

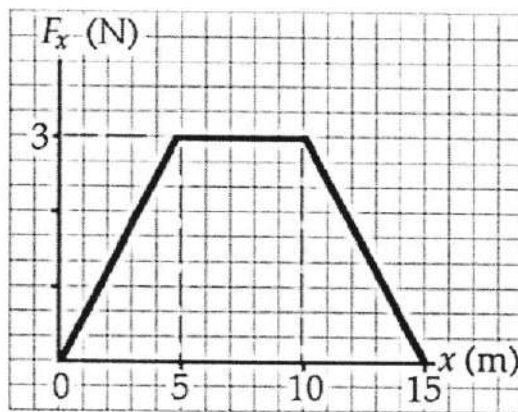
Give an account of the production, properties and application of X-rays.

10. Differentiate between Nuclear fission and Nuclear fusion reaction. Calculate energy released in the fission of 1 kg of U^{235} . [Avogadro's Number = $6.023 \times 10^{23} \text{ mol}^{-1}$ and the disintegration energy per event is 208 MeV]

OR

A particle is subject to a force F_x that varies with position as shown in Figure below. Find the work done by the force on the particle as it moves

- from $x = 0$ to $x = 5.00 \text{ m}$.
- from $x = 5.00 \text{ m}$ to $x = 10.0 \text{ m}$.
- from $x = 10.0 \text{ m}$ to $x = 15.0 \text{ m}$.
- What is the total work done by the force over the distance $x = 0$ to $x = 15.0 \text{ m}$?



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SECTION "A"

[10Q. \times 1 = 10 marks]

Fill in the blank space(s) by writing the most appropriate word(s) or symbol(s).

1. The absolute value expression of an inequality $0 \leq x \leq 4$ _____
2. A finite interval is said to be _____ if it contains left endpoint but not the other endpoint.
3. If $f(x) = x + 5$, and $g(x) = x^2$, then $g(f(2)) =$ _____
4. The domain of the function $y = \sqrt{x}$ is _____
5. Sometimes a _____ Piecewise defined function uses different formulas on different parts of its domain.
6. The average rate of change of the function $y = x^2$ with respect to x over the interval $[-2, 2]$ is _____
7. $\lim_{x \rightarrow 1} (x^2 + 5x - 2) =$ _____
8. If the function with domain D is continuous at every point of open interval I . Then the function has _____ value on D at a point c if $f(c) \leq f(x)$ for all x in D .
9. The derivative of the function $\int_0^x (1 - t^2) dt$ is _____
10. $\int \frac{dx}{x} =$ _____

SECTION "B"

[10 Q. \times 1 = 10 marks]

Fill in the blank space(s), **DO NOT TICK**, by selecting the most appropriate answers from among the given ones.

11. The value of $\int_{-5}^5 (ax^5 + bx + c) dx$ _____

[depends on c only; depends on a only;
depends on a and b; depends on a, b, c]

12. Suppose that f is a function that $\sqrt{1 - 2x^2} \leq f(x) \leq \sqrt{1 + 2x}$ for that are near 0 but not equal to 0 then $\lim_{x \rightarrow 0} f(x) =$ _____
 [1; -1; 2; -2]
13. The point of discontinuity of the function $f(x) = \frac{1}{x} - 3x$ at _____
 [All x; $x \geq 2$; $x \leq 2$; $x \neq 2$]
14. The value of $\int 5 dx$ _____.
 [0; C where C is a constant;
 5x; 5x+c]
15. A point at which the second derivative becomes zero is called _____
 [Critical point, point of inflection, Local Maximum, Local Minimum]
16. The derivative of $f(x) = x^{-4}$ is _____
 [$-4x^3$; $4x^3$ $-\frac{4}{x^3}$; ; $\frac{4}{x^3}$]
17. Suppose that f and g are continuous and that $\int_1^2 f(x) dx = 17$ $\int_1^5 f(x) dx = -5$ and $\int_5^1 g(x) dx = -12$ then $\int_1^5 [g(x) - f(x)] dx =$ _____
 [$\int_1^5 f(x) dx$, $\int_1^5 g(x) dx$, $\int_5^1 g(x) dx$, $\int_1^2 f(x) dx$]
18. The y-intercept of the line $x - 5y = 20$ is -----
 [-5; 5; 4; -4]
19. The given square matrix $A = \begin{bmatrix} 3 & 1 & 2 \\ 0 & 5 & 3 \\ 0 & 0 & 9 \end{bmatrix}$ is called - -----
 [Lower triangular matrix; Upper triangular matrix;
 Diagonal matrix; Null Matrix]
20. If $A = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, be a 2×2 matrix then A^2 is equal to -----
 [$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$, $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$, $\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$]

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SECTION "C"

[3Q × 7 = 21 marks]

1. What property must a function that is continuous on an interval $[a, b]$ have? Give examples to illustrate the fact that a function is not continuous on its interval (a, b) still be continuous on selected interval within the domain [3+4]
Discuss the continuity or discontinuity at the point at the function given by

$$y = \frac{1}{x-2} - 3x$$

OR

What does the derivative of a function mean for a function to be differentiable on an open interval? Illustrate with an example.

Find the tangent and normal to the curve at the $x^2 + xy - y^2 = 1$ at the point (2, 3)

2. State first and second the fundamental theorem on integral calculus. [3+4]
Find the area of the region between the x-axis and the graph of the given function

$$f(x) = -x^2 - 2x \text{ on } [-3, 2].$$

3. When is a matrix said to be echelon form? Find the inverse of the matrix. [2+5]

$$A = \begin{bmatrix} 1 & 0 & -2 \\ -3 & 1 & 4 \\ 2 & -3 & 4 \end{bmatrix}$$

SECTION "D"

[6Q × 4 = 24 marks]

4. Find $\frac{dy}{dx}$ (any two)

a) $y = 4 - 2x - x^{-3}$

b) $y = \frac{\cos x}{1 + \sin x}$

c) $y = \cos^{-1}(x^2)$

5. Evaluate the following integrals (any two).

a) $\int (1 - x^2 - 3x^5) dx$

b) $\int x^3 \sin x dx$

c) $\int_{-\sqrt{3}}^{\sqrt{3}} \frac{4x}{\sqrt{x^2+1}} dx$

P.T.O.

6. Solve the initial value problem

$$\frac{dy}{dx} = 10 - x, \quad y(0) = -1$$

7. Find all the points of local maxima and minima and the corresponding maximum and minimum values of the function given $y = 6 - 2x - x^2$.

8. Evaluate the following limits.

a) $\lim_{x \rightarrow 2} \frac{x-2}{x^2-4}$

b) $\lim_{x \rightarrow 0^+} x^x$

9. Find a solution to the given system of equations is consistent

$$x - 2y + z = 0$$

$$2y - 8z = 8$$

$$-4x + 5y + 9z = -9$$

SECTION "E"

[5Q × 2 = 10 marks]

10. Find the domain and range of given function $y = \sqrt{x-4}$
11. Solve the given inequality $8 - 3x \leq 5$ and graph on the real line.
12. Find the slope of the curve $y = 5x - 3x^2$ at the point $x = 1$
13. Say whether the function $f(x) = x^3 + x$ is even, odd or neither
14. Compute AB where

$$A = \begin{bmatrix} 2 & 3 \\ 1 & -5 \end{bmatrix} \text{ and } B = \begin{bmatrix} 4 & 3 & 6 \\ 1 & -2 & 3 \end{bmatrix}$$