B.K. BIRLA CENTRE FOR EDUCATION

SARALA BIRLA GROUP OF SCHOOLS
A CBSE DAY-CUM-BOYS' RESIDENTIAL SCHOOL

**TERM-1 EXAMINATION (2025-26)**

**PHYSICS (042)**

**MARKING SCHEME**

**Class: XI** **Time: 3hr**
**Date: 10.09.25** **Max Marks: 70**

Section A (16 X 1M)

1. (a) $[ML^{-1}T^{-2}]$ 1
2. ((a) Length and Mas 1
3. (d) Speed 1
4. (b) Zero 1
5. (c) Horizontal velocity 1
6. (b) 45° 1
7. (a) Law of Inertia 1
8. (c) Watt 1
9. (c) Zero 1
10. (b) KE= 1/2 $I\omega^2$ 1
11. (b) Increase in height from Earth's surface 1
12. (b) Always negative 1
13. (a) 1
14. (c) 1
15. (c) 1
16. (a) 1

Section-B (5 X 2M)

17. Derived units are units of measurement that are created by combining base units (like meter, kilogram, second). They express quantities that are not fundamental, such as force, area, volume, or density. 2
18. A projectile is thrown with velocity 20 m/s at an angle of 60°. Calculate the time of flight.
   T=2usinɵ/g 2
   =2 x 20x (√3/2)/10
   = 3.43 s.

   Or

As $H = \frac{u \sin^2\theta}{2g}$

$\Rightarrow \quad 25 = \frac{(40)^2 \sin^2\theta}{2 \times 9.8}$

or, $\sin^2\theta = \frac{490}{(40)^2}$

or, $\sin\theta = 0.5534 \Rightarrow \theta = 33.6°$

Also $R = \frac{u^2 \sin 2\theta}{g} = \frac{(40)^2 \sin^2 (33.6)}{9.8}$

$= \frac{(40)^2 \times \sin 67.2}{9.8}$

$= \frac{(40)^2 \times 0.9219}{9.8} = 150.5$ m.

19. Proof of W-E Theorem for constant force 2

$v^2 - u^2 = 2as$

Multiplying both sides by ½ m

½ m $v^2$ - ½ m $u^2$ = ½ m X 2as

$K_f - K_i = F.s$

$K_f - K_i = W$

Change in kinetic energy is equals to the work done on a body.

20. 2

Then, $x = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3}$

$= \frac{[100(0) + 150(0.5) + 200(0.25)]}{(100 + 150 + 200)}$

$= \frac{75 + 50}{450} = \frac{125}{450} = \frac{5}{18}$ M.

$y = \frac{[100(0) + 150(0) + 200(0.25\sqrt{3})]}{450}$

$= \frac{50\sqrt{3}}{450} = \frac{\sqrt{3}}{9} = \frac{1}{3\sqrt{3}}$ M.

21. 2

**The Universal law of gravitation:** Every object in the universe attracts every other object with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres.

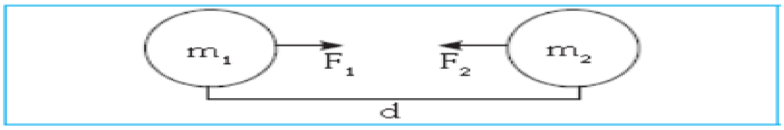



*Fig 1.1 Gravitational force between two objects.*

Let $m_1$ and $m_2$ be the masses of two objects, the distance between their centres be 'd'.

The gravitational attraction between the two will be given by,

$F \propto \frac{m_1 m_2}{d^2}$

$F = \frac{G m_1 m_2}{d^2}$ (G is constant)

G is called gravitational constant; it is also known as Universal constant of gravitation.

Or

Potential energy is the stored energy an object has due to its position or condition. In the case of gravitational potential energy, it's the energy an object has because of its location within a gravitational field.
The gravitational potential energy is defined as zero at an infinite distance from the Earth. As an object moves closer to Earth, the gravitational force does work on it, bringing it closer. This work done by gravity is negative, meaning the potential energy becomes more negative as the object gets closer to Earth.

$$W = \int_{\infty}^{r} \left(\frac{GMm}{x^2}\right)dx$$

$$W = -\left(\frac{GMm}{r}\right) - \left(-\frac{GMm}{\infty}\right)$$

$$W = \frac{-GMm}{r}$$

**SECTION-C (7 X 3M)**

22. Dimensional analysis is a powerful tool for checking the consistency of equations and relating physical quantities, but it has limitations. It cannot determine the values of dimensionless constants (like pi or 2 in the pendulum equation) or derive relationships involving trigonometric, exponential, or logarithmic functions. Additionally, it cannot be used to derive relationships with more than three variables or those with dimensionless constants. 3

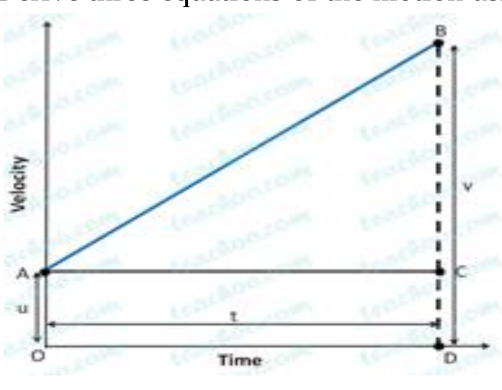
Or

$K = [M] \times [LT^{-1}])^2$
$K = [M] \times [L^2T^{-2}]$
$K = [ML^2T^{-2}]$

23. S= ut +1/2 at$^2$ 3

S= 5 X10 + ½ X 2 X100
= 150 m

24. Derive three equations of the motion using graphical method 3




First Equation of motion

Acceleration= Change in velocity/ time

a= (v-u)/(t-0)

v-u=at --------------------(i)

**Second equation of motion**

We know that

Distance = Area under v-t graph

Distance = Area of OABD

Distance = Area of rectangle OACD + Area of Δ ABC

$$s = OA \times OD + \frac{1}{2} \times AC \times BC$$

$$s = u \times t + \frac{1}{2} \times t \times (v-u) \quad ...(1)$$

From 1st equation of motion

$v = u + at$

$v - u = at$

$S = ut + ½ at^2$ --------------------- (ii)

Third Equation of Motion

S= Ar OABDO

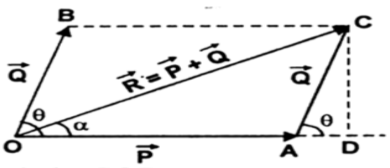
= ½(OA+BD) X OD

= ½ (v+ u) (v-u)/a

= $(v^2-u^2)/2a$

$v^2 - u^2 = 2as$ ----------------------------- (iii)

25. 3




In right angled ΔCOD,

$$OC^2 = OD^2 + CD^2$$
$$= (OA + AD)^2 + CD^2$$
$$= (OA^2 + AD^2 + 2OA.AD) + CD^2$$
$$= P^2 + Q^2\cos^2\theta + 2PQ\cos\theta + Q^2\sin^2\theta$$

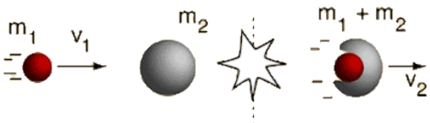
or $OC^2 = P^2 + Q^2 + 2PQ\cos\theta$

$\therefore \quad R = OC = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$

Let α be the angle which the resultant $\vec{R}$ makes with $\vec{P}$, then from ΔCOD,

$$\tan\alpha = \frac{CD}{OD} = \frac{CD}{OA + AD} = \frac{Q\sin\theta}{P + Q\cos\theta}$$

26. 3




From conservation of momentum:

$$m_1 v_1 = (m_1 + m_2) v_2 \Rightarrow v_2 = \frac{m_1}{m_1 + m_2} v_1$$

The ratio of kinetic energies before and after is:

$$\frac{KE_f}{KE_i} = \frac{\frac{1}{2}(m_1 + m_2)\left[\frac{m_1}{m_1 + m_2} v_1\right]^2}{\frac{1}{2} m_1 v_1^2} = \frac{m_1}{m_1 + m_2}$$

The fraction of kinetic energy lost is:

$$\frac{KE_i - KE_f}{KE_i} = \frac{\left[1 - \frac{m_1}{m_1 + m_2}\right] KE_i}{KE_i} = \frac{m_2}{m_1 + m_2}$$

RHS is a positive number, means always loss in energy.

27. $KE = \frac{1}{2} I \omega^2$ 3

$= \frac{1}{2} (1/2\ mr^2)\ \omega^2$

$= \frac{1}{2} \times 0.625 \times 10^4$

$= 3125J$

$L = I \omega = 0.625 \times 100 = 62.5\ kgm^2/s$

The kinetic energy is 3125 J and the angular momentum is 62.5 kg·$m^2$/s

28. 3

**(i)** **Kepler's First Law:** Planets orbit the sun in elliptical paths, not perfect circles. The sun is positioned at one of the foci (singular: focus) of the ellipse.

**(ii)** **Kepler's Second Law** :

Imagine a line connecting a planet to the sun. This line sweeps out equal areas in equal intervals of time. This means a planet moves faster when it's closer to the sun (at perihelion, the point of closest approach) and slower when it's farther away (at aphelion, the point of farthest approach).

**(iii)** **Kepler's Third Law:**

The square of a planet's orbital period (the time it takes to complete one orbit) is directly proportional to the cube of the semi-major axis of its orbit. The semi-major axis is half the length of the longest diameter of the ellipse. This law implies that planets farther from the sun have longer orbital periods.

## SECTION-D (Case Study Based Questions)

29. A car starts from rest and accelerates uniformly at 2 $m/s^2$. (1 + 1 + 1 + 1)

(i) 10 m/s

(ii) 25 m

(iii) 2$m/s^2$

(iv) Non-Uniform motion/Accelerated motion

30. A body of mass 10 kg is lifted to a height of 5 m. (2 + 1 + 1 )

(i) U= mgh

= 10 X 10 X5

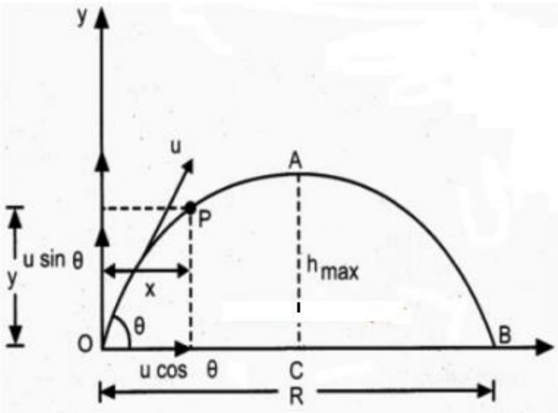
= 500 J

(ii) 10 m/s

(iii) The work done by gravity during the fall is 500 J.

## SECTION-E

31. 5




Let T is the time to reach the projectile at maximum height

Time of flight $T_f = 2T$

$= 2u\sin\theta / g$

$u_y = u\sin\theta,\ a_y = -g,\ y = H,\ t = \frac{T}{2}$

Using the relation $y = u_y t + \frac{1}{2}a_y t^2$, we have

$$H = (u\sin\theta)\frac{T}{2} + \frac{1}{2}(-g)\left(\frac{T}{2}\right)^2$$

or $$H = (u\sin\theta)\frac{u\sin\theta}{g} - \frac{1}{2}g\left(\frac{u\sin\theta}{g}\right)^2$$

or $$\boxed{H = \frac{u^2\sin^2\theta}{2g}} \quad ...(5)$$

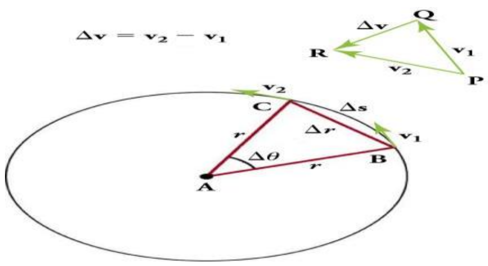
$$\therefore \quad R = u\cos\theta \times T = u\cos\theta \times \frac{2u\sin\theta}{g}$$

or $$R = \frac{u^2(2\sin\theta\cos\theta)}{g}$$

As $2\sin\theta\cos\theta = \sin 2\theta$, we have

$$\boxed{R = \frac{u^2\sin 2\theta}{g}} \quad ...(6)$$

Or



angular speed $\omega = \frac{\Delta\theta}{\Delta t}$ ...(1)

Let $\vec{v}_1$ and $\vec{v}_2$ be the velocity vectors.

$$\omega\Delta t = \frac{|\Delta\vec{v}|}{|\vec{v}|} \quad [\because v = \omega r]$$

or $$\frac{|\Delta\vec{v}|}{\Delta t} = |\vec{v}|\ \omega = (\omega r)\omega = \omega^2 r \quad 1$$

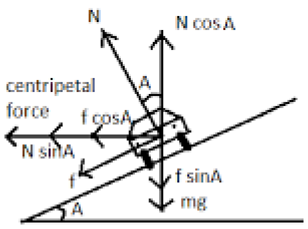
when $\Delta t \to 0$ then $\frac{|\Delta\vec{v}|}{\Delta t}$ represents the magnitude of centripetal acceleration at P, which is given by

$$|\vec{a}| = \frac{|\Delta\vec{v}|}{\Delta t} = \omega^2 r\left(\frac{v}{r}\right)^2$$

then $$|\vec{a}| = \omega^2 r = \frac{v^2}{r}$$

Example of centripetal acceleration is a stone moved around tied to the string. 1

32. 5




Circular roads are banked to help vehicles navigate turns safely at higher speeds by utilizing the horizontal component of the normal force to contribute to the necessary centripetal force. This reduces reliance on friction and allows for safer cornering, especially at higher speeds.

Taking $f = \mu_s N$ for Maximum speed and getting

$$N = \frac{mg}{\cos\theta - \mu s \sin\theta}$$

Arriving at $$V_{max} = Rg\left(\frac{\mu_s + \tan\theta}{1 - \mu_s \tan\theta}\right)^{\frac{1}{2}}$$

(b) To avoid skidding, $\mu Rg > V^2$

$0.6 \text{ X } 50 \text{ X } 10 > (50 \text{ X} 5/18)^2$

300>193

It will not skid

Or

(a) Friction is a force that opposes motion between two surfaces in contact. Limiting friction is the maximum value of static friction that can be exerted before an object starts to move. In essence, static friction prevents motion, and limiting friction is the point where that static friction can no longer hold, and the object begins to slide.

(b) Friction can be reduced by several methods including lubrication, polishing surfaces, using ball bearings, and streamlining objects. Lubricants like oil or grease create a thin layer between surfaces, reducing direct contact and friction. Polishing makes surfaces smoother, minimizing the interlocking of irregularities. Ball bearings convert sliding friction into rolling friction, which is significantly less. Streamlining, particularly in vehicles, reduces air or water resistance.

(c) Ball bearings are key components used in multiple industries to ensure efficient operation of machinery and systems. These mechanical devices reduce friction between moving parts, enabling smooth rotary motion and even load distribution.

33. 5

This work is done at the cost of kinetic energy given to the body at the surface of the earth. If $v_e$ is the escape velocity of the body projected from the surface of earth, then

Kinetic energy of the body,

$$\frac{1}{2}mv_e^2 = \frac{GMm}{R}$$

$$v_e^2 = \frac{2GM}{R}$$

$$v_e = \sqrt{\frac{2GM}{R}} \quad ...(1)$$

$$g = \frac{GM}{R^2}$$

$$GM = gR^2$$

Putting this value in (1),

$$v_e = \sqrt{\frac{2gR^2}{R}}$$

$$= \sqrt{2gR} \quad ...(2)$$ **1**

$$V_e = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2R^2 g}{R}} = \sqrt{2Rg}$$

$$V_e = \sqrt{2 \times 6.4 \times 10^6 \times 9.8} = \sqrt{19.6 \times 6.4 \times 10^6}$$

$$V_e = \sqrt{196 \times 64 \times 10^4} = 14 \times 8 \times 10^2$$

$$V_e = 112 \times 10^2 = 11.2 \times 10^3 \text{ m/s}$$

$$V_e = 11.2 \text{ km/s}$$

Or

(a) For Above the earth's surface

$$g = \frac{GM}{R^2} - - - - (i)$$

when the body is at height h, g' is given by

$$g' = \frac{GM}{(R+h)^2} - - - - (ii)$$

Now

$$\frac{g'}{g} = \frac{R^2}{(R+h)^2} = \frac{R^2}{R^2\,(1+\frac{h}{R})^2} = \frac{1}{(1+\frac{h}{R})^2}$$

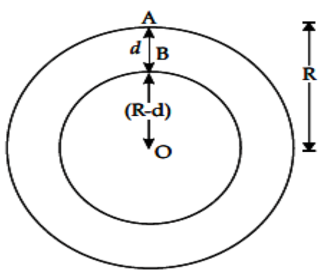
$$g' = g\left(1+\frac{h}{R}\right)^{-2}$$

Applying binominal expression for $(1+\frac{h}{R})^{-2}$ and neglecting high

$$g' = g\left(1-\frac{2h}{R}\right)$$

(b)

$$\text{then } g = \frac{GM}{R^2} \qquad ...(1)$$




$$\therefore \quad g = \frac{G \times \frac{4}{3}\pi R^3 \rho}{R^2} = \frac{4}{3}\pi G R\rho \qquad ...(2)$$

$$\therefore \qquad g' = \frac{GM'}{(R-d)^2} \quad \text{and} \quad M' = \frac{4}{3}\pi(R-d)^3\rho$$

$$\therefore \qquad g' = \frac{G \times \frac{4}{3}\pi(R-d)^3\rho}{(R-d)^2} = \frac{4}{3}\pi G(R-d)\rho \qquad \textbf{...(3)}$$

Dividing (3) by (2), we get

$$\frac{g'}{g} = \frac{\frac{4}{3}\pi G(R-d)\rho}{\frac{4}{3}\pi GR\rho} = \frac{R-d}{R} = \frac{R}{R} - \frac{d}{R} \text{ or } g' = g\left(1-\frac{d}{R}\right)$$

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