SAMPLE CONTENT

MHT-CET

TEST SERIES

PHYSICS

WITH ANSWER KEY & SOLUTIONS

1530 MCQs

- **24** Topic Tests
- **08** Revision Tests
- **05** Model Test Papers

Target Publications® Pvt. Ltd.

Based on the **Latest Paper Pattern** of MHT-CET prescribed by State Common Entrance Test Cell, Government of Maharashtra

MHT-CET

TEST SERIES

1530 MCQs

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  - ***24 Topic Tests***
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- Contains a variety of questions, formulated through a comprehensive analysis of all MHT-CET 2023 examination papers.
- Answers provided to all the questions
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PREFACE

Target's **'MHT-CET Physics Test Series'** is a complete practice book, extremely handy and a go to tool for the preparation of MHT-CET examination.

The core objective of the book is to help students gauge their preparedness to appear for MHT-CET examination, as it includes a beautiful assortment of MCQs in the form of Topic Tests and Revision Tests along with Model Test Papers as per the latest paper pattern.

- **Topic Tests** are provided for powerful concept building.
- **Revision Tests** develop confidence in the students as it includes MCQs from different topics**.**
- **Model Tests** help students to improve their performance in physics by analyzing their strengths and shortcomings.

MCQs are meticulously developed after a thorough analysis of the MHT-CET 2023 Examination (all shift question papers). The compilation of diverse question types serves as an invaluable resource for exam preparation. This also aligns with the learning objectives, subject matter and cognitive skills expected of MHT-CET aspirants.

We have provided answers to all the questions along with detailed solutions for difficult questions.

We are sure that, these question papers would provide ample practice to students in a systematic manner and would boost their confidence to face the challenges posed in examinations.

We wish the students all the best for their examinations!

Publisher

Edition: Second

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

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A book affects eternity; one can never tell where its influence stops.

NEW PAPER PATTERN

- There will be three papers of Multiple Choice Questions (MCQs) in 'Mathematics', 'Physics and Chemistry' and 'Biology' of 100 marks each.
- Duration of each paper will be 90 minutes.
- Questions will be based on the syllabus prescribed by Maharashtra State Board of Secondary and Higher Secondary Education with approximately 20% weightage given to Std. XI and 80% weightage will be given to Std. XII curriculum.
- Difficulty level of questions will be at par with JEE (Main) for Mathematics, Physics, Chemistry and at par with NEET for Biology.
- There will be no negative marking.
- Questions will be mainly application based.
- Details of the papers are as given below:

Paper	Subject(s)	No. of MCQs based on		Mark(s) Per Question	Total Marks	Duration in Minutes
		Std XI	Std XII			
Paper I	Mathematics	10	40	2	100	90
Paper II	Physics	10	40	1	100	90
	Chemistry	10	40			
Paper III	Biology	20	80	1	100	90

- Questions will be set on
  i. the entire syllabus of Std. XII of Physics, Chemistry, Mathematics and Biology subjects prescribed by Maharashtra Bureau of Textbook Production and curriculum Research, Pune, and
  ii. chapters / units from Std. XI curriculum as mentioned below:

Sr.no	Subject	Chapters/Units of Std. XI
1	Physics	Motion in a Plane, Laws of Motion, Gravitation, Thermal Properties of Matter, Sound, Optics, Electrostatics, Semiconductors
2	Chemistry	Some Basic Concepts of Chemistry, Structure of Atom, Chemical Bonding, Redox Reactions, Elements of Group 1 and Group 2, States of Matter (Gaseous and Liquid States), Adsorption and Colloids (Surface Chemistry), Hydrocarbons, Basic Principles of Organic Chemistry
3	Mathematics	Trigonometry II, Straight Line, Circle, Measures of Dispersion, Probability, Complex Numbers, Permutations and Combinations, Functions, Limits, Continuity
4	Biology	Biomolecules, Respiration and Energy Transfer, Human Nutrition, Excretion and Osmoregulation

- **Language of Question Paper:**
  The medium for examination shall be English / Marathi / Urdu for Physics, Chemistry and Biology. Mathematics paper shall be in English only.
- **Duration of Online Computer Based Test (CBT):**
  The duration of the examination for PCB is 180 minutes and PCM is 180 minutes.
  a. **For PCM -** This paper is having 2 Groups of Physics-Chemistry and Mathematics with total 180 Minutes Duration, first 90 minutes Physics and Chemistry will be enabled and only after completion of first 90 minutes' time Physics-Chemistry group will be auto submitted and Mathematics group will be enabled with 90 minutes' duration.
  b. **For PCB -** This paper is having 2 Groups of Physics-Chemistry and Biology with total 180 Minutes Duration, first 90 minutes Physics and Chemistry will be enabled and only after completion of time response for Physics-Chemistry group will be auto submitted and Biology group will be enabled with 90 minutes' duration.

[Note: Candidate should note that if he/she is appearing for both the groups i.e. PCM and PCB, the Percentile / Percentage score of Physics or Chemistry will not be interchanged among the groups.**]**

INDEX

Time: 40 min Total Marks: 40

1. A large number of bullets are fired in all directions with a speed of 150 m/s. What is the maximum area on the ground on which these bullets will spread (Take $g = 10\ m/s^2$)
(A) $3 \times 10^7\ m^2$ (B) $1.6 \times 10^7\ m^2$
(C) $1.2 \times 10^7\ m^2$ (D) $8 \times 10^7\ m^2$

2. The angular velocity of a wheel is 60 rad/s. If the radius of the wheel is 0.3 m, then linear velocity of the wheel is
(A) 18 m/s (B) 15 m/s
(C) 35 m/s (D) 28 m/s

3. An athlete completes one round of a circular track of radius R in 50 s. What will be his displacement at the end of 2 min 30 s?
(A) zero (B) 2R
(C) $2\pi R$ (D) $7\pi R$

4. The maximum height attained by projectile is increased by 20% by changing the angle of projection, without changing the speed of projection. The percentage increase in the time of flight will be
(A) 20% (B) 15%
(C) 10% (D) 5%

5. A body thrown with an initial speed of 80 ft/s reaches the ground after ($g = 32\ ft/s^2$)
(A) 3 s (B) 5 s (C) 12 s (D) 8 s

6. If a car travelling at 72 km/h overtakes another car travelling at 40 km/h, the relative velocity of first car with respect to another car is
(A) −18 km/h (B) 32 km/h
(C) 98 km/h (D) 112 km/h

7. A shell is fired at an angle of 60° to the horizontal with velocity 115.4 m/s. The time of flight is
(A) 6.5 s (B) 12.8 s
(C) 16.5 s (D) 20.4 s

8. If the equation of a projectile is $y = x - \frac{gx^2}{2}$, then the angle of projection is
(A) 80° (B) 60° (C) 45° (D) 30°

9. An object moving with a speed of 12.25 m/s, is decelerated at a rate given by $\frac{dv}{dt} = -2.5\sqrt{v}$ where v is the instantaneous speed. The time taken by the object, to come to rest, would be
(A) 1.2 s (B) 2.8 s
(C) 4.3 s (D) 8.4 s

10. A particle is moving with constant acceleration and v_1, v_2 and v_3 are the average velocities of the particle in three successive intervals t_1, t_2 and t_3. Which of the following relations will be correct?
(A) $\frac{v_1 - v_3}{v_2 - v_3} = \frac{t_1 - t_2}{t_2 + t_3}$ (B) $\frac{v_1 - v_2}{v_2 - v_3} = \frac{t_1 - t_2}{t_1 - t_3}$
(C) $\frac{v_1 - v_2}{v_2 - v_3} = \frac{t_1 - t_2}{t_2 - t_3}$ (D) $\frac{v_1 - v_2}{v_2 - v_3} = \frac{t_1 + t_2}{t_2 + t_3}$

11. When a body is projected vertically up from the ground, its velocity is reduced to $\left(\frac{1}{4}\right)^{th}$ of its initial value at height y above the ground. The maximum height reached by the body is
(A) $\frac{3}{4y}$ (B) $\frac{8y}{15}$
(C) $\frac{9y}{16}$ (D) 9y

12. A particle starts from rest, accelerates at $3\ m\ s^{-2}$ for 20 s and then goes for constant speed for 30 s and then decelerates at $4\ m\ s^{-2}$ till it stops. The distance travelled is
(A) 2850 m (B) 2200 m
(C) 2750 m (D) 2500 m

13. A ball is dropped from a highly raised platform at t = 0 starting from rest. After 9 second another ball is thrown downwards from the same platform with a speed v. The two balls meet at t = 20 s. What is the value of v?
(Take $g = 10\ m/s^2$)
(A) 126.8 m/s (B) 132.5 m/s
(C) 129.6 m/s (D) 140 m/s

14. A particle is moving on a circular path with constant speed, then its acceleration will be
(A) zero.
(B) external radial acceleration.
(C) internal radial acceleration.
(D) constant acceleration.

15. The angle of projection for a projectile thrown perpendicular to horizontal is
(A) 90° (B) 60°
(C) 45° (D) 0°

16. Match the motions given in column I with nature of their respective displacement - time graph given in column II:

	Column - I		Column - II
i.	Projectile motion	a.	Straight line parallel to x-axis
ii.	Simple harmonic motion	b.	Parabolic path
iii.	Non-uniform acceleration along X-axis	c.	Sinusoidal curve
iv.	Uniform circular motion	d.	Curved line with varying slope

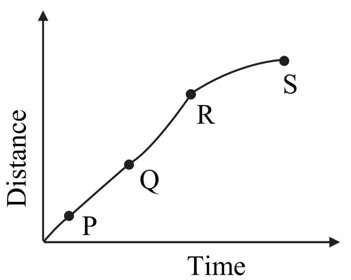
(A) i – c, ii – a, iii – b, iv - d
(B) i – d, ii – c, iii – b, iv - a
(C) i – b, ii – c, iii – d, iv - a
(D) i – b, ii – a, iii – d, iv - c

17. The angle between velocity and acceleration of a particle describing uniform circular motion is
(A) 180° (B) 90°
(C) 45° (D) 60°

18. Which of the following is NOT an example of a projectile?
(A) Aeroplane in flight.
(B) A bullet fired from the gun.
(C) A hammer thrown by an athlete.
(D) A stone thrown from the top of the building.

19. A ball is rolled off the edge of a horizontal table at a speed of 6 m/second. It hits the ground after 0.3 second. Which statement given below is true?
(A) It hits the ground at a horizontal distance 2.6 m from the edge of the table.
(B) The speed with which it hits the ground is 4.0 m/second.
(C) Height of the table is 0.45 m.
(D) It hits the ground at an angle of 60^{o} to the horizontal.

20. A particle shows distance-time curve as shown in the figure. The slope of the particle is maximum at
(A) P
(B) S
(C) R
(D) Q



21. A proton of mass 1.6×10^{-27} kg goes round in a circular orbit of radius 0.10 m under a centripetal force of 6×10^{-13} N. The frequency of revolution of the proton is about
(A) 0.1×10^{8} cycles per s
(B) 4×10^{8} cycles per s
(C) 8×10^{8} cycles per s
(D) 12×10^{8} cycles per s

22. A particle first accelerates from rest and then retards to rest during the time interval of 12 s. If the retardation is 2 times the acceleration, then the time for which it accelerated is
(A) 2 s (B) 3 s
(C) 4 s (D) 8 s

23. A projectile can have the same range R for two angles of projection. If t_1 and t_2 are the times of flight in the two cases, then the product of the two time of flight is proportional
(A) R^2 (B) $\frac{1}{R^2}$
(C) $\frac{1}{R}$ (D) R

24. A river is flowing from west to east at a speed of 5 m/min. In what direction should a man on the south bank of the river, capable of swimming at 15 m/min in still water, swim to cross the river in the shortest time?
(A) East - North (B) West - North
(C) South - West (D) North – West

25. While plotting graph, independent variable (i.e., time) is plotted along _______.
(A) x-axis (B) y-axis
(C) z-axis (D) negative z-axis

26. A person travels along a straight road due east for the first half distance with speed v_1 and the second half distance with speed v_2, the average speed of the person is
(A) $\frac{v_1 + v_2}{2}$ (B) $\frac{v_1}{2} + \frac{v_2}{2}$
(C) $\frac{v_1 + v_2}{2v_1v_2}$ (D) $\frac{2v_1v_2}{v_1 + v_2}$

27. When a car moves towards east 40 m then towards south 40 m, later on towards west 40 m, finally towards north 40 m, the displacement of the car in magnitude is
(A) 200 m (B) 100 m
(C) 50 m (D) zero

28. A particle covers 50 m distance when projected with an initial speed. On the same surface it will cover a distance, when projected with four times the initial speed
(A) 100 m (B) 150 m
(C) 800 m (D) 250 m

29. An electron travelling with a speed of 8×10^3 m/s passes through an electric field with an acceleration of 10^{12} m/s^2. How long will it take for electron triple its speed?

(A) 1.6×10^{-8} s (B) 0.6×10^{-10} s
(C) 5×10^{-9} s (D) 16×10^{-10} s

30. A boat is moving with velocity of $2\hat{i} + 5\hat{j}$ in river and water is moving with a velocity of $-2\hat{i} - 5\hat{j}$ with respect to ground. Relative velocity of boat with respect to water is

(A) $-4\hat{i} - 10\hat{j}$ (B) $4\hat{i} + 10\hat{j}$
(C) $8\hat{i}$ (D) $6\hat{i}$

31. A cricketer can throw a ball to a maximum horizontal distance of 120 m. How much high above the ground can the cricketer throw the same ball?

(A) 100 m (B) 75 m
(C) 30 m (D) 25 m

32. If a tension in a string is 4.2 N. A load at the lower end of a string is 0.2 kg, the length of string is 8 m then find its angular velocity ($g = 10$ m/s^2)

(A) 0.12 rad/s (B) 3.42 rad/s
(C) 1.62 rad/s (D) 1.43 rad/s

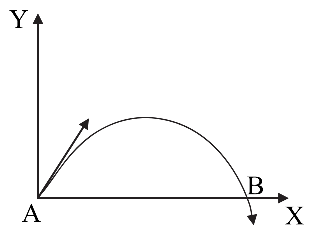
33. A small coin is kept at the rim of a horizontal circular disc which is set into rotation about vertical axis passing through its centre. If radius of the disc is 8 cm and $\mu_s = 0.4$, then the angular speed at which the coin will just slip is

(A) 5 rad/s (B) 7 rad/s
(C) 10 rad/s (D) 4.9 rad/s

34. The horizontal distance x and the vertical height y of a projectile at a time t are given by $x = at$ and $y = bt^2 + ct$ where a, b and c are constants. The magnitude of the velocity of the projectile 1 second after it is fired is

(A) $[a^2 + (2b + c)^2]^{1/2}$
(B) $[2a^2 + (b + c)^2]^{1/2}$
(C) $[2a^2 + (2b + c)^2]^{1/2}$
(D) $[a^2 + (b + 2c)^2]^{1/2}$

35. The velocity of a projectile at the initial point A is $\left(3\hat{i} + 4\hat{j}\right)$ m/s. Its velocity (in m/s) at point B is



(A) $-3\hat{i} - 4\hat{j}$
(B) $-3\hat{i} + 4\hat{j}$
(C) $3\hat{i} - 4\hat{j}$
(D) $3\hat{i} + 4\hat{j}$

36. The length of the string of a conical pendulum is 20 m and it has a bob of mass 30 g. The angle that the string makes with the vertical is 30°. If the bob covers one revolution in 3 s, then the corresponding centripetal force acting on the bob will be

(A) 10 N (B) 1.3 N
(C) 1.5 N (D) 5 N

37. A particle is moving with velocity 8 m/s towards east and its velocity changes to 8 m/s north in 20 s. Find the acceleration.

(A) $\sqrt{2}$ N – W (B) $\frac{1}{\sqrt{2}}$ N – W
(C) $\frac{1}{\sqrt{2}}$ N – E (D) $\frac{2\sqrt{2}}{5}$ N – E

38. A shell is fired from canon with a velocity of 300 m/s at an angle of 45° with the horizontal. The horizontal range attained by it is ($g = 10$ ms^{-2})

(A) 2×10^2 m (B) 9×10^3 m
(C) 4×10^4 m (D) 8×10^3 m

39. The speed of a boat is 10 km/hr in still water. It crosses a river of width 2 km along the shortest possible path in 20 minutes. The velocity of the river water is nearly

(A) 1 km/hr (B) 3 km/hr
(C) 4 km/hr (D) 5 km/hr

40. The height y and the distance x along the horizontal, for a body projected in the vertical plane are given by $y = 4t - 10t^2$ and $x = 6t$, the initial velocity at $t = 0$ of the body is

(A) $12\sqrt{3}$ m/s (B) $2\sqrt{13}$ m/s
(C) $3\sqrt{5}$ m/s (D) $2\sqrt{19}$ m/s

Laws of Motion

Topic Test 02

Time: 40 min | Total Marks: 40

1. If a rifle is fixed on the ground and fired, which of the following statement is CORRECT?

(A) The bullet will not return to the ground.
(B) Newton's third law of motion is not obeyed.
(C) Newton's third law of motion is obeyed.
(D) Recoil force doesn't act on rifle.

2. A body having mass m and moving with velocity 4 km h^{-1} collides with a body at rest having mass 5m and sticks to it. The combined mass will begin to move with a velocity

(A) 0.42 km h^{-1} (B) 0.38 km h^{-1}
(C) 0.52 km h^{-1} (D) 0.67 km h^{-1}

3. A bomb of mass 8 kg explodes into two pieces of mass 2 kg and 6 kg. The velocity of mass 2 kg is 16 m/s, the kinetic energy of mass 6 kg is

(A) 85.23 J (B) 92.84 J
(C) 284.2 J (D) 76.46 J

4. The unit of torque is same as ______.

(A) power (B) acceleration
(C) momentum (D) work

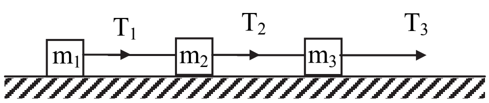
5. A particle moves from (2, 0, 4) to the point (–5, 3, 6), when a force $\vec{F} = \left(\hat{i} + 7\hat{k}\right)$ acts on it. Amount of work done in joule is

(A) 14 J (B) 10 J
(C) 7 J (D) 15 J

6. The kinetic energy of a body of mass 8 kg and momentum 10 Ns will be

(A) 14.5 J (B) 6.25 J
(C) 25.5 J (D) 3.25 J

7. Three blocks of masses m_1, m_2 and m_3 are connected by massless strings as shown in figure on a frictionless table. They are pulled with a force T_3 = 40 N. If m_1 = 12 kg, m_2 = 5 kg and m_3 = 2 kg, the tension T_2 will be



(A) 20 N (B) 35.8 N
(C) 16.2 N (D) 42.2 N

8. A ball is thrown vertically down from height of 40 m from the ground with an initial velocity 'v'. The ball hits the ground, loses $\frac{1}{3}^{rd}$ of its total mechanical energy and rebounds back to the same height. If the acceleration due to gravity is 10 ms^{-2}, the value of 'v' is

(A) 5 ms^{-1} (B) 10 ms^{-1}
(C) 15 ms^{-1} (D) 20 ms^{-1}

9. **Assertion:** The centre of mass of a body may lie where there is no mass.
Reason: The centre of mass has nothing to do with the mass.

(A) Assertion is True, Reason is True; Reason is a correct explanation for Assertion.
(B) Assertion is True, Reason is True; Reason is not a correct explanation for Assertion.
(C) Assertion is True, Reason is False.
(D) Assertion is False, Reason is True.

10. A man weighing 90 kg is in a lift moving down with an acceleration of 2 ms^{-2}. The force exerted by the floor on him is

(A) 588 N (B) 480 N
(C) Zero (D) 702 N

11. A cricket ball of mass 0.4 kg strikes a cricket bat normally with a velocity of 30 m s^{-1} and rebounds with a velocity of 15 m s^{-1}. The impulse of the force exerted by the ball on the bat is

(A) 18 N s (B) 25 N s
(C) 30 N s (D) 10 N s

12. A bullet moving with a speed of 500 m/s penetrates a sand bag and drops dead inside it. The masses of the bullet and the sand bag are 0.3 kg and 5 kg respectively. If the bag is free to move, its velocity shall be (in m/s)

(A) 10 m/s (B) 30 m/s
(C) 21 m/s (D) 50 m/s

13. What is the torque of force $\vec{F} = \left(4\hat{i} - 2\hat{j} - 5\hat{k}\right)$ N acting at a point $\vec{r} = \left(2\hat{i} + 2\hat{j} + 3\hat{k}\right)$ m about the origin?

(A) $\left(-4\hat{i} + 22\hat{j} - 12\hat{k}\right)$ Nm
(B) $\left(-2\hat{i} + 12\hat{j} + 22\hat{k}\right)$ Nm
(C) $\left(-\hat{i} - 8\hat{j} - 12\hat{k}\right)$ Nm
(D) $\left(2\hat{i} - 3\hat{j} - 12\hat{k}\right)$ Nm

14. Which of the following states the action reaction law?
(A) Elasticity
(B) Kepler's laws
(C) Newton's laws
(D) Conservation of linear momentum

15. Which of the given force does not depend on charge?
(A) Strong nuclear
(B) Electrostatic
(C) Electromagnetic
(D) None of the above

16. In an inertial frame of reference
(A) newton's laws of motion do not hold good.
(B) fictitious force act on it.
(C) newton's laws of motion hold good for real forces.
(D) the frame accelerates uniformly.

17. A force vector applied on a mass is represented as $\vec{F} = \left(8\hat{i} - 12\hat{j} + 14\hat{k}\right)$ N and accelerates with 2 m s^{-2}. What will be the mass of the body?
(A) $\sqrt{101}$ kg (B) 101 kg
(C) $2\sqrt{101}$ kg (D) 201 kg

18. If two balls each of mass 0.08 kg moving in opposite directions with speed 5 m/s collide and rebound with the same speed, then the impulse imparted to each ball due to other is
(A) 0.8 kg m/s (B) 0.24 kg m/s
(C) 0.81 kg m/s (D) Zero

19. A mass of 20 kg is suspended from a rope wound on a wheel of diameter 80 cm. The torque about the axis of rotation is
(A) 39.2 Nm (B) 19.6 Nm
(C) 54.2 Nm (D) 78.4 Nm

20. A force $\vec{F} = 5\hat{i} - 6\hat{j} + 2\hat{k}$ is acting at a point $\vec{r}_1 = \hat{i} + 2\hat{j} + 3\hat{k}$. The torque acting about a point $\vec{r}_2 = 3\hat{i} - 2\hat{j} - 4\hat{k}$ is
(A) zero (B) $50\hat{i} - 32\hat{j} + 7\hat{k}$
(C) $42\hat{i} + 30\hat{j} + 6\hat{k}$ (D) $50\hat{i} + 39\hat{j} - 8\hat{k}$

21. A boy holds a hydrogen-filled balloon with a string. He is sitting in a train moving with uniform velocity on a straight track. The string is vertical. On applying brakes, the balloon will
(A) be thrown forward
(B) be thrown backward
(C) remain vertical
(D) fall downwards

22. The gravitational force of attraction between Earth and Jupiter, if the distance between them is 8.5×10^8 km, is
[mass of Jupiter = 2×10^{27} kg, mass of the Earth = 6×10^{24} kg]
(A) 2.45×10^{29} N (B) 2.12×10^{26} N
(C) 1.11×10^{18} N (D) 5.14×10^{18} N

23. A bullet leaves the rifle of mass one kg and rifle recoils thereby with velocity 40 cm/s. If the mass of the bullet is 2 g, the velocity of the bullet is
(A) 2×10^4 cm/s (B) 3×10^2 cm/s
(C) 2×10^2 cm/s (D) 20 cm/s

24. The coefficient of restitution is zero in ____
(A) perfectly elastic collision.
(B) perfectly inelastic collision.
(C) partly elastic collision.
(D) partly inelastic collision.

25. The direction of torque is given by _______.
(A) direction of force only
(B) direction of moment arm
(C) right hand screw rule
(D) left hand screw rule

26. A particle in an inertial frame of reference
(A) is decelerated.
(B) is accelerated.
(C) is either accelerated or decelerated.
(D) moves with constant velocity or it is at rest.

27. A force of F = (0.2x + 14) N acts on a particle. If x is in metre, calculate the work done by the force during the displacement of the particle from x = 0 to x = 4 m.
(A) 128.3 J (B) 57.6 J
(C) 64.7 J (D) 52.8 J

28. Choose the CORRECT statement for an inelastic collision.
(A) The momentum, kinetic energy and total energy are conserved.
(B) The momentum, kinetic energy and total energy are not conserved.
(C) The momentum and kinetic energy are conserved but total energy is not conserved.
(D) The total energy and momentum are conserved but kinetic energy is not conserved.

29. The work done is negative, if the kinetic energy _____.
(A) increases (B) decreases
(C) becomes zero (D) becomes infinite

30. Force applied to open or close a bottle cap is an example of _______.
(A) elastic collision
(B) conservation of momentum
(C) couple of force
(D) application of Newton's law of motion

31. A uniform bar RS weighs 100 g and is 60 cm long. From the end R, two masses 50 g and 100 g are hung from the bar at a distance of 15 cm and 50 cm respectively. If the bar is to remain horizontal when balanced on a knife-edge, its position is

(A) 42 cm from S (B) 35 cm from R
(C) 35 cm from S (D) 42 cm from R

32. Centre of mass of 3 particles 8 kg, 12 kg and 22 kg is at (0, 0, 0). Where should a particle of mass 40 kg be placed, so that the centre of mass of combination will be at (3, 3, 3)?

(A) (0, 0, 0) (B) (6.15, 6.15, 6.15)
(C) (1.5, 2.5, 3.5) (D) (4.12, 4.12, 4.12)

33. A ladder 2 m long and of weight 200 N has its centre of gravity 1 m from its bottom. A weight of 60 N is attached to the top end. The work required to raise the ladder from the horizontal position to the vertical position is

(A) 190 J (B) 250 J
(C) 230 J (D) 320 J

34. A ball moving with a speed of 15 m s^{-1} strikes an identical ball at rest such that after the collision the direction of each ball makes an angle 45° with the original line of motion. Find the speeds of the two balls after the collision.

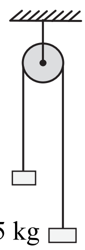
(A) $v_1 = 5.2\sqrt{2}$ m/s, $v_2 = 10.5\sqrt{2}$ m/s
(B) $v_1 = 10\sqrt{2}$ m/s, $v_2 = 10\sqrt{2}$ m/s
(C) $v_1 = 7.5\sqrt{2}$ m/s, $v_2 = 7.5\sqrt{2}$ m/s
(D) $v_1 = 3\sqrt{2}$ m/s, $v_2 = 15\sqrt{2}$ m/s

35. A body of mass 80 kg is suspended using a spring balance inside a lift at rest. If the lift starts falling freely, the reading of the spring balance is

(A) < 50 kg (B) = 50 kg
(C) > 50 kg (D) = 0 kg

36. Two blocks of masses 3 kg and 5 kg are attached with massless string passing over a fixed frictionless pulley as shown in the figure. When released, the velocity of the centre of mass of the system of two blocks after 2 seconds is
(Acceleration due to gravity = 10 ms^{-2})

(A) 1.25 ms^{-1} upward
(B) 2.5 ms^{-1} upward
(C) 1.25 ms^{-1} downward
(D) 2.5 ms^{-1} downward



37. A force of 12 N, making an angle θ with the horizontal, acting on an object displaces it by 0.8 m along the horizontal direction. If the object gains kinetic energy of 1 J, the horizontal component of the force is

(A) 1.5 N (B) 1.25 N
(C) 3.5 N (D) 4.5 N

38. 8 m long see-saw remains horizontal when two children weighing 28 kg and 32 kg respectively sit at two ends. Where is the see-saw supported?

(A) 3.62 m from 28 kg
(B) 2.62 m from 32 kg
(C) 4.27 m from 28 kg
(D) 4.27 m from 32 kg

39. A ball of mass 10 kg travelling with velocity of 20 cm/s makes a head on collision with another ball of mass 2 kg which is at rest. After the collision, the speed of the lighter ball is

(A) zero.
(B) less than 20 cm/s.
(C) equal to 20 cm/s.
(D) greater than 20 cm/s.

40. Which of the following force follows inverse square law?

(A) Strong nuclear
(B) Weak nuclear
(C) Gravitational force
(D) All of the above

Gravitation — Topic Test 03

Time: 40 min | Total Marks: 40

1. Consider a light planet revolving around a massive star in a circular orbit of radius 'r' with time period 'T'. If the gravitational force of attraction between the planet and the star is proportional to $r^{-\frac{n}{2}}$, then T^2 is proportional to

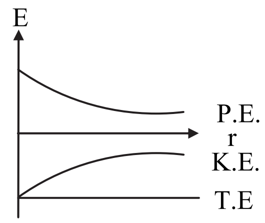
(A) $r^{(n+2)/2}$ (B) $r^{-(n+2)/2}$
(C) $r^{n/2}$ (D) $r^{-n/2}$

2. If the distance between the sun and the earth is increased by two and a half times, then attraction between two will

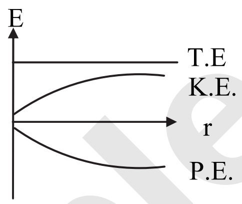
(A) remain constant. (B) decrease by 63%.
(C) decrease by 84%. (D) decrease by 89%.

3. The correct graph representing the variation of total energy (T.E.), kinetic energy (K.E.) and potential energy (P.E.) of a satellite with its distance (r) from the centre of the earth is

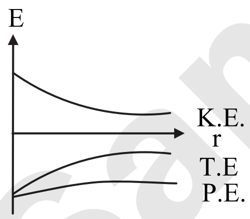
(A)



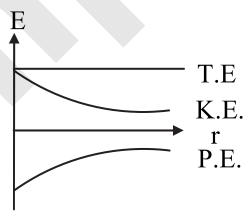
(B)



(C)



(D)



4. A body weighs 50 N on the surface of the Earth while at a depth d below the surface Earth, the weight is 25 N. The value of d is

(A) 0.4 R (B) 0.5 R
(C) 0.8 R (D) R

5. Time period of revolution of a nearest satellite around a planet of radius R is T. Period of revolution around another planet, whose radius is 5R but density twice the first planet is

(A) $T/\sqrt{2}$ (B) 3T
(C) 5T (D) $5\sqrt{3}T$

6. If the value of gravitational acceleration at a depth d below the surface of the earth is twice to that on the surface of the earth at latitude of angle ϕ, then

(A) $\phi = \cos^{-1}\left[\sqrt{\dfrac{R\omega}{gd}}\right]$

(B) $\phi = \cos^{-1}\left[\dfrac{\sqrt{d}}{R^2\omega^2}\right]$

(C) $\phi = \cos^{-1}\left[\dfrac{\sqrt{g(R+d)}}{\sqrt{2}\,R\omega}\right]$

(D) $\phi = \cos^{-1}\left[\dfrac{\sqrt{gd}}{R\omega}\right]$

7. If the earth of radius R, while rotating with angular velocity ω becomes stand still, what will be the effect on the weight of a body of mass m at latitude of 60°?

(A) Remains unchanged
(B) Decreases by $R\,\omega^2$
(C) Increases by $R\,\omega^2/4$
(D) Increases by $R\,\omega^2/2$.

8. Time period of second pendulum on a planet, whose mass and diameter are half that of earth, is

(A) $\sqrt{2}$ s (B) 2 s
(C) $2\sqrt{2}$ s (D) $\dfrac{1}{\sqrt{2}}$ s

9. A body of mass m rises to a height h = R/6 from the surface of the Earth. If g is acceleration due to gravity on the Earth's surface, then the increase in potential energy is (R = radius of Earth)

(A) mgh (B) $\dfrac{4}{5}$ mgh
(C) $\dfrac{5}{6}$ mgh (D) $\dfrac{6}{7}$ mgh

10. Two-point masses each equal to 1.7 kg attract one another with a force of 2.89×10^{-9} kg-wt. The distance between the point masses is

(A) 8 cm (B) 0.8 cm
(C) 80 cm (D) 0.08 cm

11. Consider a planet in some solar system which has mass half the mass of the Earth and density equal to the average density of the Earth. An object weighing W on the Earth will weigh

(A) $2^{2/3}$ W (B) 2W
(C) W/2 (D) $2^{5/3}$ W

12. A satellite is launched into a circular orbit of radius R around the earth. A second satellite is launched into an orbit of radius (1.02)R. The period of the second satellite is larger than that of the first one by approximately.
(A) 0.5% (B) 3.0%
(C) 1.5% (D) 1.0%

13. The acceleration due to gravity at a height $1/10^{th}$ of the radius of a spherical planet above the its surface is 10.5 ms^{-2}. Its value at a point at an equal distance below the surface in ms^{-2} is about
(A) 8.5 (B) 9.8
(C) 11.81 (D) 13.12

14. Two equal masses, each equal to m are suspended from a balance whose scale pans differ in vertical height by h. The error in weighing in terms of density of earth ρ is
(A) $\pi G\rho mh$ (B) $\frac{1}{3}\pi G\rho mh$
(C) $\frac{8}{3}\pi G\rho mh$ (D) $\frac{4}{3}\pi G\rho mh$

15. The maximum vertical distance through which a full dressed astronaut can jump on the earth is 60 cm. Estimate the maximum vertical distance through which he can jump on the moon, which has a mean density $2/3^{rd}$ that of earth and radius one quarter that of the earth.
(A) 1.5 m (B) 3.6 m
(C) 6 m (D) 7.5 m

16. Mass M is divided into two parts xm and (1 − x)m. For a given separation, the value of x_m for which the gravitational attraction between the two pieces becomes maximum is
(A) $\frac{1}{2}$ (B) $\frac{3}{5}$ (C) 1 (D) 2

17. The value of acceleration due to gravity at a depth of 800 km is equal to
(A) 8.58 ms^{-2} (B) 9.8 ms^{-2}
(C) 7.35 ms^{-2} (D) 19.6 ms^{-2}

18. A satellite is orbiting close to the earth and has a kinetic energy E. The minimum extra kinetic energy required by it to just overcome the gravitation pull of the earth is
(A) E (B) $\sqrt{E}$
(C) $\sqrt{2}$ E (D) 2 E

19. Two satellites A and B go round a planet in circular orbits having radii 9R and R, respectively. If the speed of satellite A is nv, then speed of satellite B is
(A) 9 nv (B) 3 nv
(C) $\sqrt{3}$ nv (D) nv

20. The gravitational potential due to a point mass M at a distance r (>R) from the centre of earth is given by,
(A) $V = \frac{-GM}{r^2}$ (B) $V = \frac{g}{r}$
(C) $V = \frac{-g}{r}$ (D) $V = \frac{-GM}{r}$

21. The gravitational force on a body of mass 8 kg at the surface of the earth is 80 N. If earth is a perfect sphere, the gravitational force on a satellite of mass 350 kg in a circular orbit of radius same as diameter of the earth is
(A) 80 N (B) 350 N
(C) 3500 N (D) 875 N

22. A spring balance is graduated on sea level. If a body is weighed with this balance at consecutively increasing depth from earth's surface, the weight indicated by the balance
(A) will go on increasing continuously.
(B) will go on decreasing continuously.
(C) will remain same.
(D) will first increase and then decrease.

23. $[M^{-1} L^3 T^{-2}]$ are dimensions of _______.
(A) gravitational torque.
(B) gravitational potential
(C) universal gravitational constant
(D) gravitational field

24. To increase gravitational acceleration of the planet
(A) its size should decrease with its mass unchanged.
(B) its mass should increase with its size unchanged.
(C) its mean density should increase.
(D) all of the above.

25. The value of 'g' at a certain height h above the free surface of Earth is $\frac{x}{8}$ where x is the value of 'g' at the surface of Earth. The height h is
(A) 0.8R (B) 1.2R
(C) 1.83R (D) 8R

26. If earth stops rotating then as a consequence,
(A) centripetal force will vanish and value of 'g' will increase.
(B) centrifugal force will vanish and value of 'g' will decrease.
(C) value of 'g' will become zero.
(D) day and night will not occur but value of 'g' will be unaffected.

27. A body weighs 27 N on the surface of the earth. What is the gravitational force on it due to earth at a height equal to half the radius of the earth from the surface?
(A) 72 N (B) 27 N
(C) 36 N (D) 12 N

28. The rotational period of a satellite close to the surface of the earth is 87 minutes. The time period of another earth satellite in an orbit at a distance three times the radius of earth from its surface will be
(A) 87 minutes.
(B) $87 \times \sqrt{3}$ minutes.
(C) 452 minutes.
(D) 261 minutes.

29. The earth (mass = 6×10^{24} kg) revolves around the sun in circular orbit of radius 1.5×10^{8} km. If gravitational force exerted by the sun on the earth is 3.6×10^{22} N, then earth's angular velocity of revolution is
(A) 2×10^{-7} m/s (B) 4×10^{-7} m/s
(C) 4×10^{-7} rad/s (D) 2×10^{-7} rad/s

30. A satellite of mass m moving around the earth of mass m_E in a circular orbit of radius R has angular momentum L. The rate of the area swept by the line joining the centre of the earth and satellite is
(A) directly proportional to L and m.
(B) inversely proportional to L and m.
(C) directly proportional to m and inversely proportional to L.
(D) directly proportional to L and inversely proportional to m.

31. Two solid spheres of radius r and 2r, made of same material, are kept in contact. The mutual gravitational force of attraction between them is proportional to _______.
(A) r^4 (B) r^2
(C) r^{-2} (D) r^{-4}

32. Range of gravitational force is _______.
(A) 100 light-year (B) finite
(C) infinite (D) 1000 parsec

33. The value of 'g' at a certain height above the surface of the earth is 25% of its value on the surface. The height is (R = 6400 km)
(A) 12500 km (B) 10500 km
(C) 8000 km (D) 6400 km

34. A satellite is orbiting very close to a planet. Its periodic time is
(A) directly proportional to density of planet.
(B) directly proportional to square of density of planet.
(C) inversely proportional to square root of density of planet.
(D) inversely proportional to density of planet.

35. v_e and v_p denote the escape velocities from the earth and another planet having four times the radius and the same mean density as the earth. Then
(A) $v_e = v_p$ (B) $v_e = \frac{v_p}{2}$
(C) $v_e = 2v_p$ (D) $v_e = \frac{v_p}{4}$

36. Mass of a planet is 100 times mass of its moon and distance between then is 50 times the radius of the planet. If R is the radius of planet, then the distance between the moon and the point on the line joining the moon and the planet where gravitational force becomes zero is,
(A) 30R (B) 15R
(C) 6R (D) 4.55R

37. The value of gravitational constant is determined using
(A) spring balance.
(B) Cavendish balance.
(C) Kepler's pendulum.
(D) Compton effect.

38. The radius of the Earth shrinks by 2.5%, its mass remaining the same. The percentage change in the value of g is
(A) −2.5% (B) +2.5%
(C) −5% (D) +5%

39. If the earth suddenly contracts so that its radius reduces by 1.5% with mass remaining same, then what will happen to the escape velocity from earth's surface now?
(A) Increases by 3%
(B) Decreases by 3%
(C) Increases by 1.5%
(D) Decreases by 1.5%

40. A body weighs 1400 g-wt on the surface of the earth. How much will it weigh on the surface of a planet whose mass is $\frac{1}{5}$ and radius is half that of the earth?
(A) 978 g-wt (B) 1400 g-wt
(C) 1120 g-wt (D) 670 g-wt

Time: 40 min | Total Marks: 40

1. The centre of gravity for a circular ring lies
(A) away from the ring.
(B) at the geometrical centre.
(C) on the edge of the ring.
(D) none of the above.

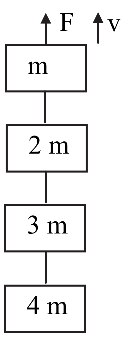
2. A bomb is fired from a cannon with a velocity of 1500 m/s making an angle of 30º with the horizontal. What is the time taken by the bomb to reach the highest point?
(A) 77 s (B) 23 s
(C) 38 s (D) 51 s

3. A body of mass 4 kg, travelling at 8 m/s makes a head-on collision with a body of mass 2 kg travelling in the opposite direction with a velocity of 3 m/s, the velocities of the two bodies after collision are
(A) $v_1 = 6.8$ m/s, $v_2 = 12.2$ m/s
(B) $v_1 = 0$ m/s, $v_2 = 0$ m/s
(C) $v_1 = 0.6$ m/s, $v_2 = 11.8$ m/s
(D) $v_1 = 6$ m/s, $v_2 = 0$ m/s

4. If both the mass and radius of Earth decrease by 4%, the value of acceleration due to gravity will decrease by nearly
(A) 4% (B) 8%
(C) 2% (D) 16%

5. The value of 'g' at a depth of 160 km will be (Radius of earth = 6400 km)
(A) 990 cm/s^2 (B) 986 cm/s^2
(C) 978 cm/s^2 (D) 955 cm/s^2

6. Four blocks with masses m, 2m, 3m and 4m are connected by strings, as shown in the figure. After an upward force F is applied on block m, the masses move upward at constant speed v. What is the net force on the block of mass 2m? (g is the acceleration due to gravity)



(A) zero
(B) 2 mg
(C) 3 mg
(D) 6 mg

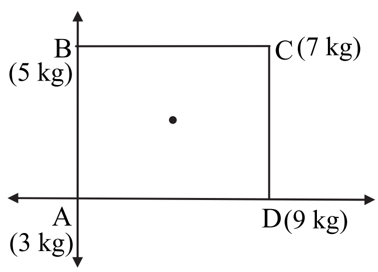
7. A particle is projected obliquely into air with velocity of 10 m/s at an angle of elevation of 30°. Neglecting air resistance the equation of motion is
(A) $y = \dfrac{x}{\sqrt{2}} - \dfrac{gx}{200}$ (B) $y = x\left[\dfrac{1}{2} - \dfrac{gx}{150}\right]$
(C) $y = x\left[\dfrac{1}{\sqrt{3}} - \dfrac{gx}{150}\right]$ (D) $y = x - \dfrac{gx^2}{200}$

8. In the HCl molecule, the separation between the nuclei of the two atoms is about 1.27 Å (1 Å = 10^{-10} m). The approximate location of the centre of mass of the molecule, assuming the chlorine atom to be about 35.5 times massive as hydrogen is
(A) 1 Å (B) 2.4 Å
(C) 1.24 Å (D) 1.5 Å

9. R is the radius of the earth and ω is its angular velocity and g_p is the value of g at the poles. The effective value of g at the latitude $\theta = 45°$ will be equal to
(A) $g_p - \dfrac{1}{2}R\omega^2$ (B) $g_p - \dfrac{3}{4}R\omega^2$
(C) $g_p - R\omega^2$ (D) $g_p + \dfrac{1}{4}R\omega^2$

10. The initial speed of a shell is 280 m/s. At what angle must the gun be fired if the projectile is to strike a target at the same level as the gun? [The gun and the target are 1568 m apart]
(Take g = 10 m/s^2) [Take sin(6°) = 0.1]
(A) 12° (B) 8°
(C) 0.1° (D) 6°

11. Point masses of 3 kg, 5 kg, 7 kg and 9 kg are placed at the corners of a square ABCD respectively whose each side is 1 m long. The position of the centre of mass of the system is



(A) $\dfrac{14}{24}$ m, $\dfrac{8}{24}$ m (B) $\dfrac{12}{24}$ m, $\dfrac{10}{24}$ m
(C) $\dfrac{15}{24}$ m, $\dfrac{10}{24}$ m (D) $\dfrac{16}{24}$ m, $\dfrac{12}{24}$ m

12. Escape velocity of a satellite of the earth at an altitude equal to radius of the earth is v. What will be the escape velocity at an altitude equal to 6R, where R = radius of the earth?

(A) v/6 (B) $\sqrt{7}$ v/2
(C) $\sqrt{2}\ v/\sqrt{7}$ (D) 6v

13. A car of mass 1000 kg moves on a circular path with constant speed of 10 m/s. It turned through 90° after travelling 785 m on the road. The centripetal force acting on the car is
(Take π = 3.14)

(A) 320 N (B) 200 N
(C) 640 N (D) 1280 N

14. Which of the following is not a property of the newton's law of gravitation?

(A) It is always attractive.
(B) It does not depend on the medium.
(C) It acts on all masses and at all the distances.
(D) It is the strongest force among all the fundamental forces.

15. The angular separation between the minute hand and the hour hand of a clock at 1:30 pm is

(A) 140° (B) 90°
(C) 165° (D) 145°

16. If two identical satellites are at R and 5R away from earth surface, the wrong statement is
(R = Radius of earth)

(A) Ratio of their total energy will be 3.
(B) Ratio of their kinetic energies will be 3.
(C) Ratio of their potential energies will be 3.
(D) None of the above.

17. Acceleration of a body when displacement equation is $4s = 8t + 2t^2$ is

(A) $\frac{5}{3}$ m/s^2 (B) 1 m/s^2
(C) 4 m/s^2 (D) 2 m/s^2

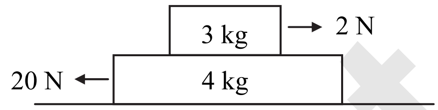
18. The ratio of relative velocity of separation after collision to the relative velocity of approach before collision between two colliding bodies is ________

(A) coefficient of restitution.
(B) velocity of collision.
(C) sum of the velocities.
(D) the law of gravitation.

19. A black hole is an object whose gravitational field is so strong that even light cannot escape from it. To what approximate radius would Venus (mass = 4.9×10^{24} kg) have to be compressed to be a black hole?

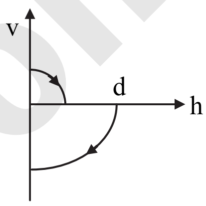
(A) 10^{-9} m (B) 10^{-6} m
(C) 10^{-2} m (D) 10^{2} m

20. In the arrangement shown in the figure, the coefficient of friction between two blocks is 0.7. The force of friction between the two blocks is (Assume that the 4 kg block is placed on a smooth horizontal surface)
(Acceleration due to gravity = 10 ms^{-2})



(A) 7.14 N (B) 12.63 N
(C) 18 N (D) 9.71 N

21. A ball is dropped vertically from a height d above the ground. It hits the ground and bounces up vertically to a height d/2. Neglecting subsequent motion and air resistance, its velocity v varies with the height h above the ground as

(A)


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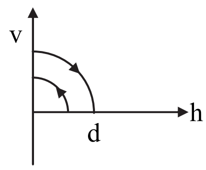

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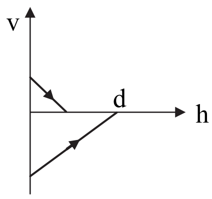

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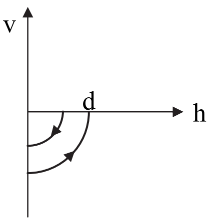


22. An aircraft is moving with a velocity of 280 ms^{-1}. If all the forces acting on it are balanced, then

(A) it will fall down instantaneously.
(B) it will lose its velocity gradually.
(C) it still moves with the same velocity.
(D) It will be just floating at the same point in space.

23. A train covers the first half of the distance between two stations at the speed of 60 km h^{-1} and the other half at 80 km h^{-1}. Its average speed is

(A) 68.57 km h^{-1}
(B) 42.6 km h^{-1}
(C) 152 km h^{-1}
(D) 52.8 km h^{-1}

24. The diameters of two planets are in the ratio 5 : 2 and their mean densities in the ratio 3 : 2. The acceleration due to gravity on the planets will be in the ratio

(A) 15 : 4 (B) 12 : 13
(C) 22 : 13 (D) 10 : 6

25. If the distance between two masses is tripled, gravitational attraction between them
(A) is tripled.
(B) becomes nine times.
(C) is reduced to three times.
(D) is reduced to nine times.

26. The value of gravitational acceleration at a height equal to twice the radius of earth, is
(A) 50 % of value at earth's surface.
(B) 25 % of value at earth's surface.
(C) 11 % of value at earth's surface.
(D) same as value at earth's surface.

27. A body projected vertically upwards with a velocity of u returns to the starting point in 10 second. If g = 9.8 m s^{-2}, the value of 'u' is
(A) 60 m/s
(B) 30.4 m/s
(C) 49 m/s
(D) 15 m/s

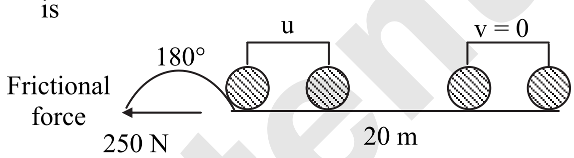
28. The CORRECT statement about Newton's second law of motion is
(A) It provides the measure of inertia.
(B) It measures the action reaction force.
(C) It relates force and momentum.
(D) It measure the work done.

29. Given below are two statements:
Statement I: $[M^0 L^2 T^{-2}]$ are dimensions of gravitational potential.
Statement II: Gravitational potential is independent of mass of the object.
In the light of above two statements, choose the most appropriate answer from the options given below.
(A) Both statement I and statement II are correct.
(B) Both statement I and statement II are incorrect.
(C) Statement I is correct but statement II is incorrect.
(D) Statement I is incorrect but statement II is correct.

30. Choose the correct relation for gravitational acceleration at latitude θ.
(A) $g - R^2\omega^2 \cos\theta$
(B) $g - R^2\omega \cos^2\theta$
(C) $g - R^2\omega^2 \cos^2\theta$
(D) $g - R\omega^2 \cos^2\theta$

31. A thief is running away on a straight road in jeep moving with a speed of 10 m s^{-1}. A police man chases him on a motor cycle moving at a speed of 15 ms^{-1}. If the instantaneous separation of the jeep from the motorcycle is 200 m, how long will it take for the police to catch the thief ?
(A) 1 s (B) 19 s
(C) 40 s (D) 100 s

32. A cyclist comes to skidding spot in 20 m. If the opposing force on the cycle due to the road is 250 N. The work done by the road on the cycle is



(A) 5000 J (B) −5000 J
(C) 1000 J (D) −1000 J

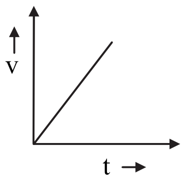
33. A 50 kg shell is flying at 40 m/s. When it explodes, its one part of 25 kg stops, while the remaining part flies on with velocity
(A) 80 m s^{-1} (B) 100 m s^{-1}
(C) 60 m s^{-1} (D) 48 m s^{-1}

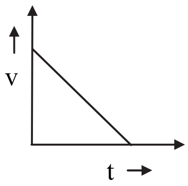
34. How much energy will be required if a mass of 5 quintal escapes from the earth?
($R_e = 6.4 \times 10^6$ m, g = 10 ms^{-2})
(A) 32×10^9 joule (B) 64×10^9 joule
(C) 1.6×10^9 joule (D) 80×10^9 joule

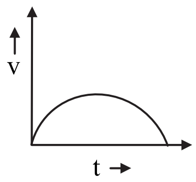
35. Select the incorrect statements from the following
S1: Average velocity is path length divided by time interval.
S2: In general, speed is greater than the magnitude of the velocity.
S3: A particle moving in a given direction with a non-zero velocity can have zero speed.
S4: The magnitude of average velocity is the average speed.
(A) S2 and S3
(B) S1 and S4
(C) S1, S3 and S4
(D) All four statements

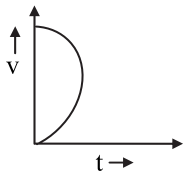
36. The period of revolution of planet A around the Sun is 12 times that of B. The distance of A from the Sun is n times greater than the distance of B from the sun. The value of n is
(A) 5.24 (B) 8.69
(C) 12.44 (D) 16.09

37. Which of the following graph cannot be velocity-time graph?

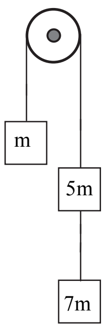
(A)


(B)


(C)


(D)


38. Three masses m, 5m and 7m are attached with light string passing over a fixed frictionless pulley as shown in the figure. The tension in the string between 5m and 7m is (g is acceleration due to gravity)



(A) 6mg
(B) 3mg
(C) 2mg
(D) mg

39. Position of a particle at any instant t is given by $\vec{r} = 4t\hat{i} + 2t^2\hat{j} + 5\hat{k}$. Its velocity at same instant will be

(A) $4t\hat{i} + 5k\hat{j}$ (B) $3\hat{i}+4\hat{j}+5\hat{k}$
(C) $4\hat{i} + 4t\hat{j}$ (D) $3t\hat{i} + 4t\hat{j}$

40. The value of universal gravitational constant G in C.G.S. system is

(A) 6.67×10^{-5} (B) 6.67×10^{-8}
(C) 6.67×10^{-9} (D) 6.67×10^{-13}

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Model Test Paper - 01

Time: 45 min | Total Marks: 50

1. A particle performs linear S.H.M. At a particular instant, velocity of the particle is 'u' and acceleration is 'α' while at another instant, velocity is 'v' and acceleration is 'β' ($0 < \alpha < \beta$). The distance between the two positions is

(A) $\frac{u^2 - v^2}{\alpha + \beta}$ (B) $\frac{u^2 + v^2}{\alpha + \beta}$

(C) $\frac{u^2 - v^2}{\alpha - \beta}$ (D) $\frac{u^2 + v^2}{\alpha - \beta}$

2. Angle of minimum deviation for a prism of refractive index 1.5, is equal to the angle of the prism. Then the angle of the prism is
(cos 41° = 0.75)

(A) 62° (B) 41°
(C) 82° (D) 31°

3. A monatomic gas expands at constant pressure on heating. The percentage of heat supplied that increases the internal energy of the gas and that is involved in the expansion are respectively

(A) 75 %, 25 % (B) 25 %, 75 %
(C) 60 %, 40 % (D) 40 %, 60 %

4. A cyclotron in which flux density is 2.8 T is employed to accelerate protons. How rapidly should the field between the dees be reversed if mass of proton be taken as 1.6×10^{-27} kg?

(A) 4.46×10^5 Hz (B) 4.46×10^7 Hz
(C) 4.46×10^4 Hz (D) 4.46×10^6 Hz

5. In an LC circuit

(A) The energy stored in L as well as in C is magnetic energy
(B) The energy stored in L is magnetic but in C it is electrical.
(C) The energy stored in L is electrical but in C it is magnetic.
(D) The energy stored in L as well as in C is electrical energy

6. The collector supply voltage is 4 V and the voltage drop across a resistor of 400 Ω in the collector circuit is 0.4 V in a transistor connected in common emitter mode. If the current gain is 20, the base current is

(A) 0.25 mA (B) 0.05 mA
(C) 0.12 mA (D) 0.02 mA

7. Two springs of spring constants 1800 N/m and 3600 N/m respectively are stretched with the same force. They will have potential energy in the ratio:

(A) 4 : 1 (B) 1 : 4
(C) 2 : 1 (D) 1 : 2

8. A mercury nucleus has a charge of +80 e where e is equal to 1.6×10^{-19} C. If a proton is at a distance of 10^{-12} m from a mercury nucleus, then its potential energy is about

(A) 11.5×10^{-15} J (B) 12.8×10^{-15} J
(C) 1.843×10^{-14} J (D) 32×10^{-38} J

9. The area of the electron orbit for the ground state of hydrogen atom is A. What will be the area of the electron orbit corresponding to the third excited state?

(A) 256A (B) 9A
(C) 81A (D) 3A

10. By sucking through a straw, a student can reduce the pressure in his lungs to 748 mm of Hg (density = 13.6 g/cm^3). Using the straw, he can drink water from a glass upto a maximum depth of

(A) 23.21 cm (B) 16.32 cm
(C) 13.6 cm (D) 1.36 cm

11. When the temperature of the system is uniform throughout the system, the system is said to be in

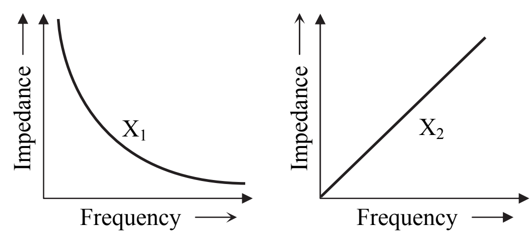
(A) mechanical equilibrium
(B) chemical equilibrium
(C) thermodynamic equilibrium
(D) thermal equilibrium

12. A ferromagnetic material is heated above its Curie temperature. Which of the following is/are correct statements?

(i) Ferromagnetic domains are perfectly arranged.
(ii) Ferromagnetic domains become random.
(iii) Ferromagnetic domains are not influenced.
(iv) Ferromagnetic material changes itself into diamagnetic material.

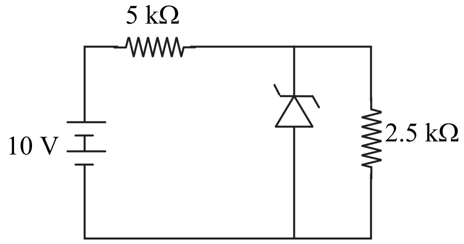
(A) (i) and (iv) (B) (ii) and (iv)
(C) only (ii) (D) only (iii)

13. The graphs given below depict the dependence of two reactive impedances X_1 and X_2 on the frequency of the alternating e.m.f. applied individually to them. We can then say that



(A) X_1 is an inductor and X_2 is a capacitor.
(B) X_1 is a resistor and X_2 is a capacitor.
(C) X_1 is a capacitor and X_2 is an inductor.
(D) X_1 is an inductor and X_2 is a resistor.

14. What will be the current flowing through the 5 kΩ resistor in the circuit shown, where the breakdown voltage of the zener is 5 V?



(A) $\frac{2}{3}$ mA (B) 1 mA
(C) 10 mA (D) $\frac{3}{2}$ mA

15. The moment of inertia of a sphere is 40 kg-m^2 about the diameter. The moment of inertia about any tangent is
(A) 25 kg m^2 (B) 40 kg m^2
(C) 140 kg m^2 (D) 70 kg m^2

16. Identify the mismatch out of the following.
(A) Static electricity – Hearing crackle when we take off synthetic clothes in dry weather.
(B) Static electricity – Lightening in the sky during thunderstorms.
(C) Static electricity – Plastic comb is electrified when it is rubbed with dry hair.
(D) Static electricity – Seeing spark in an electrical switch when we remove fuse.

17. Mass equivalence of energy 931.5 MeV is
(A) 1 unified atomic mass
(B) 1.6 amu
(C) 1 mg
(D) 1.67 mg

18. Two solid spheres of same metal but of mass M and $\frac{M}{8}$ fall simultaneously on a viscous liquid and their terminal velocities are v and nv, then value of n is
(A) 16 (B) 8
(C) 4 (D) 0.25

19. In Young's double slit experiment, when wavelength used is 8000 Å and the screen is 30 cm from the slits, the fringes are 0.012 cm wide. What is the distance between the slits?
(A) 0.024 cm (B) 2.4 cm
(C) 0.24 cm (D) 0.2 cm

20. What happens when a diamagnetic substance is brought near north or south pole of a bar magnet?
(A) It is attracted by the poles.
(B) It is repelled by the poles.
(C) It is repelled by the north pole and attracted by the south pole.
(D) It is attracted by the north pole and repelled by the south pole.

21. The volume of a metal block changes by 0.75% when heated through 196 °C then its coefficient of cubical expansion is
(A) 38.3×10^{-6} / °C (B) 84×10^{-6} / °C
(C) 46.1 10^{-5} / °C (D) 8.4×10^{-5}/ °C

22. The second overtone of a closed pipe if its fundamental frequency is 80 Hz
(A) 250 Hz (B) 400 Hz
(C) 300 Hz (D) 350 Hz

23. The ratio of the accelerations for a ring (mass m and radius R) rolling down an incline of angle 'θ' without slipping and slipping down the incline without rolling is
(A) 1 : 2 (B) 2 : 1
(C) 3 : 1 (D) 1 : $\sqrt{3}$

24. A conducting sphere of radius R = 30 cm is given a charge Q = 15 μC. What is $\vec{E}$ at centre?
(A) $3.6\times10^{6}\,\text{N/C}$ (B) $1.8\times10^{6}\,\text{N/C}$
(C) Zero (D) $0.9\times10^{6}\,\text{N/C}$

25. $\frac{\lambda_\alpha}{\lambda_\beta}$ in Brackett series is
(A) 1 (B) 1.37
(C) 1.54 (D) 2.67

26. Which of the following is the wrong pairing?
(A) Maximum height reached by a projectile - θ = 90°
(B) Maximum range of projectile - θ = 45°
(C) Same range of projectile - Complementary angles
(D) Same height reached - Complementary angles

27. Air is streaming past a horizontal air-plane wing such that its speed in 130 m/s over the upper surface and 105 m/s at the lower surface. If the density of air is 1.1 kg per metre^3 and the wing is 10 m long and has an average width of 2 m, then the difference of the pressure on the two sides of the wing is
(A) 3231 pascal (B) 409.50 pascal
(C) 1631 pascal (D) 864 pascal

28. When wavefronts pass from denser medium to rarer medium, the width of the wavefront
(A) increases.
(B) may increase or decrease.
(C) decreases.
(D) remains unchanged.

29. If the magnetic field linked with the coil is doubled, the e.m.f induced in coil will be _______.
(A) double (B) same
(C) half (D) four times

30. Gravitational force between two objects separated by 36 cm is 3.24×10^{-8} N. If total mass of the two objects is 5.0 kg, then the mass of the objects in kg, are
(A) 3, 2 (B) 4, 1
(C) 2.5, 2.5 (D) 3.5, 1.5

31. Two tuning forks A and B produce 8 beats per second when sounded together. When B is slightly loaded with wax, the beats are reduced to 6 per second. If the frequency of A is 300 Hz, the frequency of B is
(A) 300 Hz (B) 306 Hz
(C) 294 Hz (D) 350 Hz

32. A body is kept on a horizontal disc of radius 4 m at a distance of 2 m from the centre. The coefficient of friction between the body and the surface of disc is 0.8. The speed of rotation of the disc at which the body starts slipping is ($g = 10$ m/s^2)
(A) 2 rad/s (B) 6 rad/s
(C) 0.8 rad/s (D) 0.2 rad/s

33. A galvanometer has a resistance of 3774 ohm. A shunt S is connected across it such that (1/35) of the total current passes through the galvanometer. Then the value of the shunt is
(A) 3663 ohm (B) 111 ohm
(C) 107.7 ohm (D) 3555.3 ohm

34. The study of _______ is useful in understanding quantization of energy.
(A) binding energy curve
(B) diffraction of light
(C) photoelectric effect
(D) electric flux

35. Two balls of masses 9 g and 5 g are moving with kinetic energies in the ratio of 4 : 5. What is the ratio of their linear momenta?
(A) 6 : 5 (B) 5 : 6
(C) 3 : 4 (D) 4 : 3

36. Emissive power of a blackbody at a temperature 200 K is 81 J/m^{2}s. Another one is an ordinary body having emissivity 0.8 at 600 K. What is the emissive power of ordinary body?
(A) 6218.2 J/m^{2}s (B) 8000 J/m^{2}s
(C) 5248.8 J/m^{2}s (D) 1784.6 J/m^{2}s

37. The current flowing through a straight wire produces a magnetic field
(A) antiparallel to the direction of current.
(B) parallel to the wire.
(C) in the form of concentric circle.
(D) in a parabolic path.

38. The self inductance of a coil is 5 mH. If a current of 4 A is flowing in it, then the magnetic flux produced in the coil will be
(A) 0.02 weber (B) 20 weber
(C) zero (D) 2 weber

39. What should be the angular speed of an earth like planet in radian/second so that a body of 5 kg weighs zero at the equator of the planet? (Take $g_{planet} = 12$ m/s^2 and radius of planet = 7200 km)
(A) 0.89×10^{-3} (B) 1.29×10^{-3}
(C) 2.74×10^{-3} (D) 4.16×10^{-3}

40. Standing waves are produced in a 10 m long stretched string. If the string vibrates in 6 segments and the wave velocity is 36 m/s, the frequency is
(A) 15 Hz (B) 13 Hz
(C) 9 Hz (D) 11 Hz

41. Three particles, each having a charge of 10 μC are placed at the corners of an equilateral triangle of side 10 cm. The electrostatic potential energy of the system is
(A) Zero (B) 13.5 J
(C) 27 J (D) 100 J

42. In a potentiometer experiment, the balancing point with a cell is at a length 240 cm. On shunting the cell with a resistance of 4 Ω, the balancing length becomes 120 cm. The internal resistance of the cell is
(A) 1 Ω (B) 2 Ω
(C) 0.5 Ω (D) 4 Ω

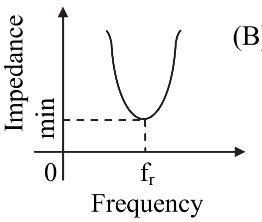
43. Out of the factors given below, upon which factor/s do/es photoelectric effect depend/s?
i. Temperature of metal plate
ii. Velocity of emitted photoelectron
iii. Frequency of incident light
(A) Only (iii) (B) (i) and (iii)
(C) (ii) and (iii) (D) (i), (ii) and (iii)

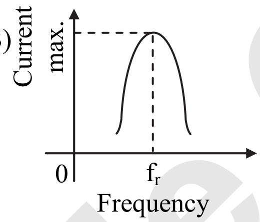
44. A/an _______ medium is required for propagation of sound.
(A) denser
(B) elastic
(C) plastic
(D) chemically ionized

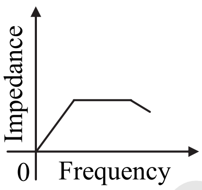
45. For principle specific heats at constant pressure and constant volume, S_P and S_V respectively, it is observed that
$S_P - S_V = a$ for hydrogen gas
$S_P - S_V = b$ for nitrogen gas
The correct relation between a and b is
(A) $a = 14b$ (B) $a = 28b$
(C) $a = \frac{1}{14}b$ (D) $a = b$

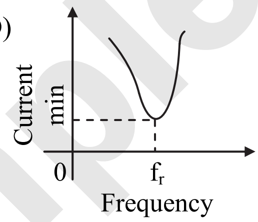
46. The force acting on a charge 'q' in both electric and magnetic field, simultaneously is
(A) $\vec{F} = \left(q\vec{E}\right) + q\left(\vec{B}\times\vec{v}\right)$
(B) $\vec{F} = \left(q\vec{E}\right) + q\left(\vec{v}\times\vec{B}\right)$
(C) $\vec{F} = \left(q\times\vec{E}\right) + q\left(\vec{v}\cdot\vec{B}\right)$
(D) $\vec{F} = \left(q\vec{E}\right) + q\left(\vec{v}\cdot\vec{B}\right)$

47. Out of the following graphs, which graph shows the correct relation (graphical representation) for LC parallel resonant circuit?

(A)


(B)


(C)


(D)


48. The solids which have the negative temperature coefficient of resistance are:
(A) insulators only
(B) semiconductors only
(C) insulators and semiconductors
(D) metals

49. The length of the seconds pendulum is increased by 0.2 %. The clock
(A) gains 51.84 seconds per day.
(B) loses 86.4 seconds per day.
(C) neither loses nor gains time.
(D) loses 6 seconds per day.

50. The potentials of two plates of a capacitor are +15 V and –15 V. The charge on one of the plates is 75 C. The capacitance of the capacitor is
(A) 2 F (B) 2.5 F
(C) 0.5 F (D) 0.25 F

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Answers & Solutions

Topic Test - 01

1. **(B)**

Area on which bullets will spread = πr^2

For maximum area,

$r = R_{max} = \dfrac{v^2}{g} = \dfrac{(150)^2}{10} = 2250$ m

…[when $\theta = 45°$]

Maximum area $\pi R^2_{max} = \pi (2250)^2 \approx 1.6 \times 10^7$ m^2

2. **(A)**

Using,

$v = r\omega = 0.3 \times 60 = 18$ m/s

3. **(A)**

Athlete completes 1 round in 50 s

2 min 30 s = 150 s

He will complete 3 rounds in 150 s.

$\therefore$ Displacement = zero

4. **(C)**

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

Differentiating partially,

$\delta H = \dfrac{u^2(2\sin\theta.\cos\theta)\delta\theta}{2g}$

$\therefore \dfrac{\delta H}{H} = \dfrac{2\cos\theta\delta\theta}{\sin\theta} = 0.2$ (given)

Similarly, $\dfrac{\delta T}{T} = \dfrac{\cos\theta\delta\theta}{\sin\theta} = 0.1$

Therefore, T increases by 10%.

5. **(B)**

Time of flight = $\dfrac{2u}{g} = \dfrac{2\times 80}{32} = 5$ s

6. **(B)**

Relative velocity of 1st car w.r.t 2nd car

$v_{12} = v_1 - v_2 = 72 - 40 = 32$ km/hr

7. **(D)**

$T = \dfrac{2u\sin\theta}{g} = \dfrac{2\times 115.4\times\sin 60°}{9.8} = 20.4$ s

8. **(C)**

Comparing with equation of projectile

$y = x\tan\theta - \dfrac{gx^2}{2u^2\cos\theta}$,

$\tan\theta = 1 \Rightarrow \theta = 45°$

9. **(B)**

$\dfrac{dv}{dt} = -2.5\sqrt{v}$

$\therefore \dfrac{dv}{\sqrt{v}} = -2.5\, dt$

$\therefore \displaystyle\int_{12.25}^{0} \frac{dv}{\sqrt{v}} = -2.5\int_0^t dt$

$\therefore \left|2\sqrt{v}\right|_{12.25}^{0} = -2.5\, t$

$\therefore 2\sqrt{12.25} = 2.5t$

$t = 2.8$ s

10. **(C)**

$\vec{v}_{avg} = \dfrac{\vec{v}_i + \vec{v}_f}{2}$

$v_1 = \dfrac{u + u + at_1}{2}$

$\therefore 2v_1 = 2u + at_1$ ….(i)

Similarly,

$2v_2 = 2u + at_2$ ….(ii)

$2v_3 = 2u + at_3$ ….(iii)

Subtracting equation (ii) from equation (i),

$2(v_1 - v_2) = a(t_1 - t_2)$ ….(iv)

Subtracting equation (iii) from equation (ii),

$2(v_2 - v_3) = a(t_2 - t_3)$ ….(v)

Dividing equation (iv) by equation (v),

$\dfrac{v_1 - v_2}{v_2 - v_3} = \dfrac{t_1 - t_2}{t_2 - t_3}$

11. **(B)**

$v^2 = u^2 - 2gy \Rightarrow \left(\dfrac{1}{4}u\right)^2 = u^2 - 2gy$

$\therefore \dfrac{u^2}{16} = u^2 - 2gy$

$\therefore u^2\left(1 - \dfrac{1}{16}\right) = 2gy$

$\therefore u^2 \times \dfrac{15}{16} = 2gy \Rightarrow \dfrac{u^2}{g} = \dfrac{16\times 2y}{15} = \dfrac{32y}{15}$

$H_{max} = \dfrac{u^2}{4g} = \dfrac{1}{4}\left(\dfrac{32y}{15}\right) = \dfrac{32y}{60} = \dfrac{8y}{15}$

12. **(A)**

For 1st part,

$v = u + at = 0 + 3 \times 20 = 60$ m s^{-1}

$s_1 = ut + \dfrac{1}{2}at^2 \Rightarrow s_1 = \dfrac{1}{2} \times 3 \times 400$

$\therefore s_1 = 600$ m

For 2nd part,

$s_2 = ut \Rightarrow s_2 = 60 \times 30$

$\therefore s_2 = 1800$ m

For 3rd part,

$v^2 = u^2 + 2as_3$

$0 = (60)^2 + 2 \times (-4) \times s_3 = 3600 - 8s_3$

$\therefore s_3 = \dfrac{3600}{8} = 450$ m

$\therefore s = s_1 + s_2 + s_3 = 600 + 1800 + 450$

$\therefore s = 2850$ m

13. (A)

Let the two balls meet after t at distance x from the platform.

Using $h = ut + \frac{1}{2}gt^2$

For the first ball

$u = 0$ m/s, $t = 20$ s, $g = 10$ m/s^2

$\therefore \quad x = \frac{1}{2} \times 10 \times (20)^2 \quad$ ....(i)

For the second ball

$u = v$, $t = 11$ s, $g = 10$ m/s^2

$\therefore \quad x = v \times 11 + \frac{1}{2} \times 10 \times (11)^2 \quad$ ....(ii)

From equations (i) and (ii),

$\frac{1}{2} \times 10 \times (20)^2 = 11v + \frac{1}{2} \times 10 \times (11)^2$

$11v = \frac{1}{2} \times 10 \times [(20)^2 - (11)^2] = \frac{1}{2} \times 10 \times 279$

$v = \frac{1395}{11} = 126.8$ m/s

14. (C)

In uniform circular motion, acceleration is caused due to change in direction and is directed radially towards centre.

15. (A) **16. (C)**

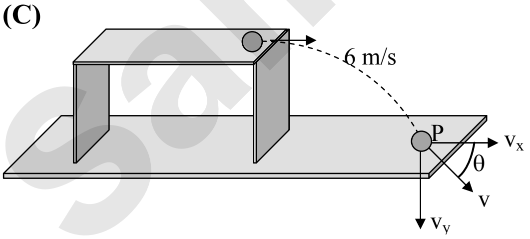
17. (B)

In a particle performing uniform cirular motion, the linear velocity of the particle is perpendicular to $\vec{r}$ and linear acceleration. The acceleration is directed towards the centre, thus making an angle of 90°.

18. (A)

An aeroplane in flight is propelled by combustion of fuel and does not move under the effect of gravity alone.

19. (C)



For a projectile given horizontal projection,
Motion along X-axis is given by,

$x = x_0 + u_x t + \frac{1}{2}a_x t^2$

Here $x_0 = 0$, $u_x = u = 6$ m/s, $a_x = 0$, $t = 0.3$ s

Hence, horizontal distance covered by the ball,

$x = ut = 6 \times 0.3 = 1.8$ m

Thus, option (A) is incorrect.

The speed with which it hits the ground,

$v = \sqrt{v_x^2 + v_y^2} = \sqrt{u^2 + g^2t^2} \quad$ ….(i)

$= \sqrt{36 + 10^2 \times (0.3)^2} \approx 6.7$ m/s

Thus, option (B) is incorrect.

Motion along Y-axis is given by

$y = y_0 + u_y t + \frac{1}{2}a_y t^2$

Here $y_0 = 0$, $u_y = 0$, $a_y = g$, $t = 0.3$ s

Hence height of the table

$h = y = \frac{1}{2}gt^2 = \frac{1}{2} \times 10 \times 0.3^2 = 0.45$ m

Thus, option (C) is correct.

The angle body makes with horizontal is

$\beta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

$= \tan^{-1}\left(\frac{3}{6}\right) \quad$ ….[Using equation (i)]

$\neq 60°$

Thus, option (D) is incorrect.

20. (C)

The slope is maximum around the point R.

21. (A)

The centripetal force acting on the proton is given by,

$F = mr\omega^2 = m\,4\pi^2n^2r$

$\therefore \quad m\,4\pi^2n^2r = 6 \times 10^{-13}$

$\therefore \quad n = \sqrt{\frac{6\times10^{-13}}{1.6\times10^{-27}\times4\times(3.142)^2\times0.1}}$

$= 9.7 \times 10^6$ cycles/s

$\therefore \quad n \approx 10 \times 10^6 = 0.1 \times 10^8$ cycles/second

22. (D)

Time taken by the particle (t) = 12 s

Let t_1 be time for acceleration and t_2 for declaration

$\therefore \quad t_1 + t_2 = 12$

$\therefore \quad t_2 = 12 - t_1 \quad$ …..(i)

For accelerated motion,

$v_0 = u + at$

$v_1 = 0 + at_1$

$v_1 = at_1 \quad$ …..(ii)

For retardation,

$v = u + at$

$\therefore \quad v_2 = v_1 + at_2 \; (\because u = v_1) \quad$ …..(iii)

Substituting equation (i), (ii) and a = – 2a, in equation (iii)

we get,

$0 = at_1 - 2a(12 - t_1)$

$\therefore \quad 2a(12 - t_1) = at_1$

$\therefore \quad 24a - 2at_1 = at_1$

$\therefore \quad 24a = 3at_1$

$\therefore \quad t_1 = 8$ s

23. **(D)**

For same range, angle of projection should be θ° and (90 – θ)°.

So, time of flights $t_1 = \dfrac{2u\sin\theta}{g}$ and

$t_2 = \dfrac{2u\sin(90-\theta)}{g} = \dfrac{2u\cos\theta}{g}$

∴ $t_1t_2 = \dfrac{4u^2\sin\theta\cos\theta}{g^2} = \dfrac{2}{g}\dfrac{(u^2\sin 2\theta)}{g} = \dfrac{2R}{g}$

∴ $t_1t_2 \propto R$

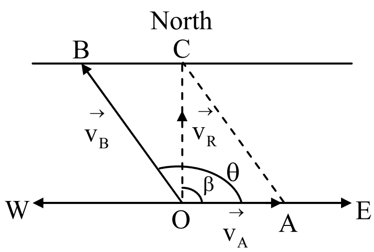
24. **(D)**

From the addition of two vectors, we know that $C^2 = A^2 + B^2 + 2AB\cos\theta$

From this expression it is clear that,

$C^2 < A^2 + B^2$ when $\theta > 90°$

i.e., when θ > 90°, the man can cross the river with shortest time.



From diagram it is clear that man should swim in north-west direction.

25. **(A)**

26. **(D)**

$t_1 = \dfrac{x/2}{v_1}$, $t_2 = \dfrac{x/2}{v_2}$

Average speed $= \dfrac{x}{t_1+t_2} = \dfrac{x}{\dfrac{x/2}{v_1}+\dfrac{x/2}{v_2}} = \dfrac{2v_1v_2}{v_1+v_2}$

27. **(D)**

28. **(C)**

$R = \dfrac{u^2\sin 2\theta}{g} \Rightarrow R \propto u^2$. So, if the speed of projection is made four times, the range becomes sixteen times,

$16 \times 50 = 800$ m

29. **(A)**

$v = u + at$

$3u = u + at \quad \Rightarrow 2u = at$

∴ $t = \dfrac{2u}{a}$

∴ $t = \dfrac{2\times 8\times 10^3}{10^{12}} = 1.6 \times 10^{-8}$ s

30. **(B)**

The relative velocity of boat w.r.t. water

$= v_{boat} - v_{water}$

$= (2\hat{i} + 5\hat{j}) - (-2\hat{i} - 5\hat{j})$

$= 4\hat{i} + 10\hat{j}$

31. **(C)**

The maximum horizontal range is given by $R_{max} = 4H_{max}$

$120 \text{ m} = 4H_{max}$

∴ $H_{max} = 30$ m

32. **(C)**

Using, $T = mr\omega^2 \Rightarrow \omega^2 = \dfrac{T}{mr}$

∴ $\omega = \sqrt{\dfrac{4.2}{0.2\times 8}} = 1.62$ rad/s

33. **(B)**

For the coin to slip;

the frictional force ≤ centripetal force

∴ $\mu_s mg \le mr\omega^2$

∴ $\mu_s g = r\omega^2$ (For minimum angular speed)

∴ $\omega^2 = \dfrac{\mu_s g}{r} = \dfrac{0.4\times 9.8}{8\times 10^{-2}} = 49$

∴ $\omega = 7$ rad/s

34. **(A)**

The horizontal component of velocity is

$v_x = \dfrac{dx}{dt} = \dfrac{d}{dt}(at) = a$

The vertical component of velocity is

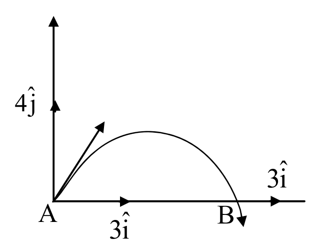
$v_y = \dfrac{dy}{dt} = \dfrac{d}{dt}(bt^2 + ct) = 2bt + c$

When t = 0, $v_x = a$, $v_y = 2b + c$

∴ $v = \sqrt{v_x^2 + v_y^2} = \sqrt{a^2 + (2b+c)^2}$

Hence, the correct choice is (A).

35. **(C)**



Horizontal (X) component remains the same while the vertical (Y) component changes.

Therefore, velocity at B = $(3\hat{i} - 4\hat{j})$ m/s.

36. **(B)**

For a conical pendulum,

$r = l \sin\theta$

$r = 20 \sin 30° \Rightarrow r = 10$ m, T = 3 s

$\therefore \quad \omega = \dfrac{2\pi}{T} = \dfrac{2\pi}{3}$

Centripetal force $= m\omega^2 r = 3 \times 10^{-2} \times \dfrac{4\pi^2}{9} \times 10$

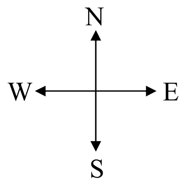
$= 131.46 \times 10^{-2} = 1.3$ N

37. **(D)**

Here, $\theta = 90°$, t = 20 s,

Resultant velocity $= \vec{v}_E - \vec{v}_N$

If the central angle is given then we apply the formula $dv = 2v \sin\dfrac{\theta}{2}$ to determine the change in velocity



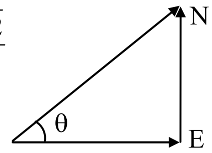
$dv = 2v \sin\left(\dfrac{\theta}{2}\right)$

$= 2 \times 8 \times \dfrac{1}{\sqrt{2}}$

$= 8\sqrt{2}$ m/s

$\therefore \quad$ Acceleration $= \dfrac{8\sqrt{2}}{20} = \dfrac{2\sqrt{2}}{5}$

Acceleration acts in N – E direction.



38. **(B)**

$R = \dfrac{u^2 \sin 2\theta}{g} = \dfrac{(300)^2 \times \sin 2(45°)}{10}$

$= \dfrac{(300)^2 \times \sin 90°}{10} = \dfrac{300 \times 300 \times 1}{10} = 9000$ m

$= 9 \times 10^3$ m

39. **(C)**

20 min = 0.33 hr

Let the velocity of the river be x km/h.

$\therefore \quad (10 - x) \times 0.33 = 2$

$\therefore \quad 10 - x = 6.06 \Rightarrow x = 3.94$ km/h ≈ 4 km/h

40. **(B)**

$v_y = \dfrac{dy}{dt} = 4 - 20t$, $v_x = \dfrac{dx}{dt} = 6$

At t = 0, $v = \sqrt{v_x^2 + v_y^2} = \sqrt{36+16} = 2\sqrt{13}$ m/s

Topic Test - 02

1. **(C)**

2. **(D)**

According to law of conservation of momentum,

$m_1u_1 + m_2u_2 = (m_1 + m_2)v$

$\therefore \quad v = \dfrac{m_1u_1 + m_2u_2}{m_1 + m_2}$

$= \dfrac{4 \times m + 5m \times 0}{m + 5m} = \dfrac{4m}{6m} = 0.67$ km/h

3. **(A)**

From the law of conservation of momentum,

$m_1 \times v_1 = m_2 \times v_2$

$\therefore \quad 2 \times 16 = 6 \times v_2$

$\therefore \quad v_2 = 5.33$ m/s

$\therefore \quad$ K.E. $= \dfrac{1}{2} \times 6 \times (5.33)^2 \approx 85.23$ J

4. **(D)**

5. **(C)**

Given: $\vec{F} = \hat{i} + 7\hat{k}$,

$\vec{s} = \vec{r}_2 - \vec{r}_1 = \left(-5\hat{i} + 3\hat{j} + 6\hat{k}\right) - \left(2\hat{i} + 4\hat{k}\right)$

$= -7\hat{i} + 3\hat{j} + 2\hat{k}$

$W = \vec{F} \cdot \vec{s} = (\hat{i} + 7\hat{k}) \cdot (-7\hat{i} + 3\hat{j} + 2\hat{k})$

$= 1 \times (-7) + 7 \times 2 = -7 + 14 = 7$ J

6. **(B)**

Momentum p = mv

Squaring and dividing by 2 on both sides we get,

$\dfrac{p^2}{2} = \dfrac{m^2v^2}{2}$

$\therefore \quad p^2 = K.E \times 2m \qquad \ldots(\because K.E = \dfrac{1}{2}mv^2)$

$\therefore \quad$ K.E. $= \dfrac{p^2}{2m} = \dfrac{100}{2 \times 8} = 6.25$ J

7. **(B)**

Common acceleration, $a = \dfrac{F}{m_1 + m_2 + m_3}$

$a = \dfrac{40}{12 + 5 + 2} = 2.1 \text{ m/s}^2$

Equation of motion for mass m_3 is

$T_3 - T_2 = m_3a$

$\Rightarrow 40 - T_2 = 2 \times 2.1 \Rightarrow T_2 = 35.8$ N

8. **(D)**

Total mechanical energy of ball,

$T = \dfrac{1}{2}mv^2 + mgh$

Total energy after the collision,

$\dfrac{2}{3}\left(\dfrac{1}{2}mv^2 + mgh\right)$

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