5000+ General SCIENCE

Chapter-wise MCQs

with Detailed Explanation for Competitive Exams

Must for SSC Railways, Defence, CDS, NDA, State PSC & CSE Exams

Includes 5 Units:
Physics | Chemistry | Biology | Technology | Ecology / Environment

disha Publication Inc

disha
Publication Inc

5000+ General SCIENCE

Chapter-wise MCQs

with Detailed Explanation for Competitive Exams

EBD_7324

Corporate Office

DISHA PUBLICATION
45, 2nd Floor, Maharishi Dayanand Marg,
Corner Market, Malviya Nagar, New Delhi - 110017
Tel : 49842349 / 49842350

Typeset by Disha DTP Team

CONTENTS

1 Measurements

Level–1

1. Temperature can be expressed as derived quantity in terms of
(a) length and mass
(b) mass and time
(c) length, mass and time
(d) None of these

2. Electron volt is a unit of
(a) potential difference (b) charge
(c) energy (d) capacity

3. Dimensions of impulse are
(a) $[MLT^{-1}]$ (b) $[MLT^{2}]$
(c) $[MT^{-2}]$ (d) $[ML^{-1}T^{-3}]$

4. Potential is measured in
(a) joule/coulomb (b) watt/coulomb
(c) newton-second (d) None of these

5. One Nanometer is equal to
(a) 10^{-9} m (b) 10^{-6}m
(c) 10^{-10} m (d) 10^{-3} m

6. Maxwell is the unit of
(a) magnetic susceptibility
(b) intensity of Magnetisation
(c) magnetic Flux
(d) magnetic Permeability

7. Which of the following is a derived physical quantity?
(a) Mass (b) Velocity
(c) Length (d) Time

8. What are the units of magnetic permeability?
(a) Wb A^{-1} m^{-1} (b) Wb^{-1} Am
(c) Wb A m^{-1} (d) Wb A^{-1} m

9. The dimensions of pressure gradient are
(a) $[ML^{-2}\ T^{-2}]$ (b) $[ML^{-2}\ T^{-1}]$
(c) $[ML^{-1}\ T^{-1}]$ (d) $[ML^{-1}\ T^{-2}]$

10. The dimensions of Rydberg's constant are
(a) $[M^0\ L^{-1}\ T]$ (b) $[MLT^{-1}]$
(c) $[M^0\ L^{-1}\ T^0]$ (d) $[ML^0\ T^2]$

11. 'Farad' is the unit of
(a) resistance (b) conductance
(c) capacitance (d) inductance

12. S.I. unit of surface tension is
(a) degree/cm (b) N/m
(c) N/m^2 (d) Nm

13. Which one of the following pairs does not have the same dimension?
(a) Potential energy and kinetic energy
(b) Density and specific gravity
(c) Focal length and height
(d) Gravitational force and frictional force

14. Which one of the following physical quantity has the same unit as that of pressure?
(a) Angular momentum (b) Stress
(c) Strain (d) Work

15. The symbol of SI unit of inductance is H. It stands for
(a) Holm (b) Halogen
(c) Henry (d) Hertz

16. Light year is a measure of
(a) time
(b) distance
(c) total amount of light falling on the Earth in a year
(d) average intensity of light falling on the Earth in a year

17. Which one of the following is not a dimension less quantity?
(a) Strain (b) Relative density
(c) Frequency (d) Angle

18. The dimensions of universal gas constant are
(a) $[L^2\ M^1\ T^{-2}\ K^{-1}]$ (b) $[L^1\ M^2\ T^{-2}\ K^{-1}]$
(c) $[L^1\ M^1\ T^{-2}\ K^{-1}]$ (d) $[L^2\ M^2\ T^{-2}\ K^{-1}]$

19. The dimensions of magnetic moment are
(a) $[L^2\ A^1]$ (b) $[L^2\ A^{-1}]$
(c) $[L^2 / A^3]$ (d) $[LA^2]$

20. The dimensions of Wien's constant are
(a) $[ML^0\ T\ K]$ (b) $[M^0\ LT^0\ K]$
(c) $[M^0\ L^0\ T\ K]$ (d) [MLTK]

21. The dimensional formula of wave number is
(a) $[M^0\ L^0\ T^{-1}]$ (b) $[M^0\ L^{-1}\ T^0]$
(c) $[M^{-1}\ L^{-1}\ T^0]$ (d) $[M^0\ L^0\ T^0]$

22. The dimensions of Hubble's constant are
(a) $[T^{-1}]$ (b) $[M^0L^0T^{-2}]$
(c) $[MLT^4]$ (d) $[MT^{-1}]$

23. The dimensions of solar constant is
(a) $[M^0\ L^0\ T^0]$ (b) $[MLT^{-2}]$
(c) $[ML^2\ T^{-2}]$ (d) MT^{-3}

24. The dimensional formula for entropy is
(a) $[MLT^{-2}\ K^1]$ (b) $[ML^2\ T^{-2}]$
(c) $[ML^2\ T^{-2}\ K^{-1}]$ (d) $[ML^2\ T^{-2}\ K]$

25. Dimensions of specific heat are
(a) $[ML^2 T^{-2} K]$ (b) $[ML^2 T^{-2} K^{-1}]$
(c) $[ML^2 T^2 K^{-1}]$ (d) $[L^2 T^{-2} K^{-1}]$

26. The physical quantity which has the dimensional formula $[M^1T^{-3}]$ is
(a) surface tension (b) solar constant
(c) density (d) compressibility

27. Which one of the following elements is used as a timekeeper in atomic clocks?
(a) Potassium (b) Caesium
(c) Calcium (d) Magnesium

28. Which one of the following is the value of one nanometer?
(a) 10^{-7} cm (b) 10^{-6} cm
(c) 10^{-4} cm (d) 10^{-3} cm

29. What is the unit of pressure?
(a) Newton/sq. meter (b) Newton-meter
(c) Newton (d) Newton/meter
(e) None of the above/More than one of the above

30. The unit of pressure is
(a) kg/cm^2 (b) kg/cm
(c) kg/mm (d) kg/cm^3

31. Which one of the following quantities **does not** have unit?
(a) Stress (b) Force
(c) Strain (d) Pressure
(e) None of the above/More than one of the above

32. Dimensional formula for thermal conductivity is (here K denotes the temperature :
(a) $MLT^{-2} K$ (b) $MLT^{-2} K^{-2}$
(c) $MLT^{-3} K$ (d) $MLT^{-3} K^{-1}$

33. Which of the following is the unit of molar gas constant?
(a) $JK^{-1} mol^{-1}$ (b) Joule
(c) JK^{-1} (d) $J mol^{-1}$

34. Density of liquid is 16.8 g cm^{-3}. Its value in the International System of Units is
(a) 16.8 kgm^{-3} (b) 168 kgm^{-3}
(c) 1680 kgm^{-3} (d) 16800 kgm^{-3}

35. The dimensional formula of couple is
(a) $[ML^2T^{-2}]$ (b) $[MLT^2]$
(c) $[ML^{-1}T^{-3}]$ (d) $[ML^{-2}T^{-2}]$

36. Subtract 0.2 J from 7.26 J and express the result with correct number of significant figures.
(a) 7.1 J (b) 7.06 J
(c) 7.0 J (d) 7 J

37. Multiply 107.88 by 0.610 and express the result with correct number of significant figures.
(a) 65.8068 (b) 65.807
(c) 65.81 (d) 65.8

38. When 97.52 is divided by 2.54, the correct result is
(a) 38.3937 (b) 38.394
(c) 38.39 (d) 38.4

39. Which of the following is the most accurate?
(a) 200.0 m (b) 20×10^1 m
(c) 2×10^2 m (d) data is inadequate

40. The area of a square is 5.29 cm^2. The area of 7 such squares taking into account the significant figures is:
(a) $37cm^2$ (b) 37.030 cm^2
(c) 37.03 cm^2 (d) 37.0 cm^2

41. The SI unit of coefficient of mutual inductance of a coil is
(a) henry (b) volt
(c) farad (c) weber

42. The S.I. unit of pole strength is
(a) Am^2 (b) Am
(c) $A m^{-1}$ (d) Am^{-2}

43. Which is dimensionless?
(a) Force/acceleration (b) Velocity/acceleration
(c) Volume/area (d) Energy/work

44. The expression $[ML^{-1} T^{-2}]$ does not represent
(a) pressure (b) power
(c) stress (d) Young's modulus

45. The dimensional formula of current density is
(a) $[M^0L^{-2}T^{-1}Q]$ (b) $[M^0L^2T^1Q^{-1}]$
(c) $[MLT^{-1}Q]$ (d) $[ML^{-2}T^{-1}Q^2]$

Level–

1. Match List I (Units) with List II (Physical quantity) and select the correct answer using the codes given below the lists.

	List I (Units)		**List II (Physical quantity)**
A.	Watt	1.	Electric charge
B.	Tesla	2.	Power
C.	Coulomb	3.	Luminous intensity
D.	Candela	4	Magnetic field

Codes:

	A	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	1	4	1	3	(b)	1	2	3	4
(c)	1	2	4	3	(d)	2	4	3	1

2. Match List I (Physical quantity) with List II (Units) and select the correct answer using the codes given below the lists.

	List I (Physical quantity)		**List II (Units)**
A.	Power	1.	$kg ms^{-1}$
B.	Energy	2.	$kg m^2s^{-1}$
C.	Momentum	3.	Nm^{-2}
D.	Pressure	4.	kW
		5.	kWh

Codes:

	A	**B**	**C**	**D**		**A**	**B**	**C**	**D**
(a)	4	5	1	3	(b)	4	5	1	2
(c)	5	4	1	2	(d)	5	4	2	3

3. What is the correct sequence in which the lengths of the following units increase?
1. Angstrom
2. Micron
3. Nanometer

Select the correct answer using the code given below:
(a) 1, 2, 3 (b) 3, 1, 2
(c) 1, 3, 2 (d) 2, 3, 1

4. Match List 'I' (Physical quantity) with list II (Dimension) and select the correct answer by using the codes given below the lists.

	List I (Physical quantity)		List II (Dimension)
A.	Density	1.	$[MLT^{-2}]$
B.	Force	2.	$[ML^{-3}]$
C.	Energy	3.	$[MLT^{-1}]$
D.	Momentum	4.	$[ML2T^{-2}]$

Codes:

	A	B	C	D		A	B	C	D
(a)	3	2	4	1	(b)	1	2	3	4
(c)	2	1	4	3	(d)	3	2	1	4

5. Match List I (Physical quantity) with list II (Units) and select the correct answer by using the codes given below the lists.

	List I (Physical quantity)		List II (Units)
A.	Solid angle	1.	pascal
B.	Impulse	2.	steradian
C.	Viscosity	3.	Newton-second
D.	Pressure	4.	Pascal-second

Codes:

	A	B	C	D		A	B	C	D
(a)	2	4	3	1	(b)	2	3	4	1
(c)	1	4	3	2	(d)	1	3	4	2

6. Which of the following is most accurate?
(a) A screw gauge of least count 0.001 mm
(b) A screw gauge having pitch 1 mm and 50 divisions on circular scale
(c) A vernier callipers of least count 0.01 mm
(d) Vernier callipers having 20 divisions on the sliding scale (vernier scale) coinciding 19 divisions on the main millimetre scale.

7. Which of the following quantities has a unit but dimensionless?
(a) Strain
(b) Reynolds number
(c) Angular displacement
(d) Poisson's ratio

8. The displacement of a body at a particular second n is given by the expression $S_{nth} = u + \frac{a}{2}(2n-1)$. The dimensional formula of S_{nth} in this equation is
(a) $[M^1L^0T^1]$ (b) $[M^0L^1T^0]$
(c) $[M^0L^1T^{-1}]$ (d) $[M^0L^0T^0]$

9. The division of energy by time is X. The dimensional formula of X is same as that of
(a) momentum (b) power
(c) torque (d) electric field

10. The dimensions of electromotive force in terms of current A are
(a) $[MT^{-2}A^{-2}]$ (b) $[ML^2T^{-2}A^2]$
(c) $[ML^2T^{-2}A^{-2}]$ (d) $[ML^2T^{-3}A^{-1}]$

11. $[MLT^{-1}] + [MLT^{-1}] =$ .....
(a) $[M^\circ L^\circ T^\circ]$ (b) $[MLT^{-1}]$
(c) $2[MLT^{-1}]$ (d) None of these

12. Which physical quantities have same dimensions?
(a) Moment of couple and work
(b) Force and power
(c) Latent heat and specific heat
(d) Work and power

13. If e is the charge, V the potential difference, T the temperature, then the units of $\frac{eV}{T}$ are the same as that of
(a) planck's constant (b) stefan's constant
(c) boltzmann constant (d) gravitational constant

14. In the eqn. $\left(P + \frac{a}{V^2}\right)(V-b) = \text{constant}$, the unit of a is
(a) dyne × cm^5 (b) dyne × cm^4
(c) dyne/cm^3 (d) dyne × cm^2

15. The least count of an instrument is 0.01 cm. Which of the following reading denotes the one, measured by this instrument?
(a) 1.04 cm (b) 2.001 cm
(c) 3.1 cm (d) None of these

16. Match List-I with List-II and select the correct answer using the codes given below the lists:

	List-I		List-II
A.	Wavelength	1.	Hertz
B.	Energy	2.	Angstrom
C.	Intensity of sound	3.	Joule
D.	Frequency	4.	Decibel

Codes:

	A	B	C	D
(a)	2	3	4	1
(b)	1	2	3	4
(c)	2	3	1	4
(d)	2	1	3	4

17. Match List-I with List-II and select the correct answer with the help of codes given below:

	List-I		List-II
A.	Temperature	1.	Kelvin
B.	Power	2.	Watt
C.	Pressure	3.	Pascal
D.	Force	4.	Newton

Codes:

	A	B	C	D
(a)	2	1	3	4
(b)	1	2	4	3
(c)	1	2	3	4
(d)	2	1	4	3

18. Match List-I with List-II and select the correct answer from the codes given below:

List-I		**List-II**
A.	Acceleration	1. Joule
B.	Electric current	2. Newton second
C.	Work done	3. Ampere
D.	Impulse	4. Metre per sec^2.

Codes:

	A	B	C	D
(a)	1	2	3	4
(b)	2	3	4	1
(c)	4	3	1	2
(d)	3	4	1	2

19. Which one of the following statements is correct?

(a) The measurment of mass taken by a spring weighing balance is correct at the place where the spring balance is calibrated for

(b) The measurment of mass taken by a spring weighing balance is correct at all places

(c) The measurment of mass taken by a spring weighing balance is correct at the places where the acceleration due to gravity is same with the place where the spring balance is calibrated for

(d) A spring balance cannot be used to measure mass at any place

20. Which one of the following statements is *not* correct?

(a) The SI unit charge is ampere-second

(b) Debye is the unit of dipole moment

(c) Resistivity of a wire of length / and area of cross-section a depends upon both *l* and a

(d) The kinetic energy of an length of mass in kg and charge / coulomb when accelerated through a potential difference of V volt, is ev joule.

HINTS & EXPLANATIONS

Level–1

1. **(d)** Temperature is one of the basic physical quantities.

2. **(c)** Electron volt is a unit of energy &
$1eV = 1.6\times10^{-19}$ joule

3. **(a)** Impulse = force × time $= MLT^{-2}\times T = [M^1\,LT^{-1}]$.

4. **(a)** Potential is work done per unit charge.

5. **(a)**

6. **(c)** Maxwell is the unit of magnetic flux in C.G.S system.
1 Wb(S.I unit) = 10^8 maxwell

7. **(b)**

8. **(a)** From Biot Savart's law

$$B = \frac{\mu_0}{4\pi}\frac{i\,dl\sin\theta}{r^2}$$

$$\mu_0 = \frac{4\pi\,Br^2}{i\,dl\sin\theta} = \frac{Wb\,m^{-2}m^2}{Am} = Wb\,A^{-1}m^{-1}$$

9. **(a)** Pressure gradient $= \dfrac{\text{Pressure difference}}{\text{distance}}$.

$$[\text{Pressure gradient}] = \frac{ML^{-1}T^{-2}}{L} = \left[ML^{-2}T^{-2}\right]$$

10. **(c)** From $\dfrac{1}{\lambda} = R\left(\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right)$,

$$\text{dimensions of } R = \frac{1}{L} = L^{-1} = [M^0\,L^{-1}\,T^0]$$

11. **(c)** **12.** **(b)** **13.** **(b)** **14.** **(b)** **15.** **(c)**

16. **(b)** **17.** **(c)**

18. **(a)** $R = \dfrac{PV}{\mu T} = \dfrac{W}{\mu T} = \dfrac{ML^2\,T^{-2}}{\text{mol}\,K}$

where μ is number of mole of the gas
$= [M^1L^2T^{-2}K^{-1}\text{mol}^{-1}]$

19. **(a)** M = current × area $= AL^2 = [L^2\,A^1]$

20. **(b)** $b = \lambda_m\,T = LK = [M^0\,L^1\,T^0\,K^1]$

21. **(b)** Wave number $\bar{\nu} = \dfrac{1}{\lambda} = \dfrac{1}{L} = [M^0\,L^{-1}\,T^0]$.

22. **(a)** Hubble's constant, $H = \dfrac{\text{velocity}}{\text{distance}} = \dfrac{[LT^{-1}]}{[L]}$

$$= [T^{-1}] = 70\times10^{-3}\ N/m.$$

23. **(d)** Solar constant = energy/sec/area

$$= \frac{ML^2\,T^{-2}}{TL^2} = [MT^{-3}]$$

24. **(c)** Entropy $= \dfrac{Q}{T} = \dfrac{ML^2\,T^{-2}}{K} = [ML^2\,T^{-2}\,K^{-1}]$

25. **(d)** $s = \dfrac{Q}{m\theta} = \dfrac{ML^2T^{-2}}{MK} = [L^2\,T^{-2}\,K^{-1}]$

26. **(b)** Solar constant = energy/area/time

$$= \frac{ML^2\,T^{-2}}{L^2\,T} = [M^1\,T^{-3}].$$

27. **(b)** **28.** **(a)** **29.** **(a)** **30.** **(e)** **31.** **(c)**

32. **(d)** From formula, $\dfrac{dQ}{dt} = kA\dfrac{dT}{dx} \Rightarrow k = \dfrac{\left(\dfrac{dQ}{dt}\right)}{A\left(\dfrac{dT}{dx}\right)}$

$$[k] = \frac{[ML^2T^{-3}]}{[L^2][KL^{-1}]} = [MLT^{-3}K^{-1}]$$

33. **(a)** $R = \dfrac{PV}{nT} = \dfrac{J}{\text{mol}\,K} = J\,K^{-1}\,\text{mol}^{-1}$.

34. **(d)** $16.8\ gcm^{-3} = 16800\ Kgm^{-3}$.

35. **(a)** Dimensionally couple = Torque = Work

36. **(a)** Subtraction is correct upto one place of decimal, corresponding to the least number of decimal places.
$7.26 - 0.2 = 7.06 = 7.1$ J.

37. **(d)** Number of significant figures in multiplication is three, corresponding to the minimum number
$107.88\times0.610 = 65.8068 = 65.8$

38. **(d)** $\dfrac{97.52}{2.54} = 38.393 = 38.4$ (with least number of significant figures, 3).

39. **(a)**

40. **(c)**

41. **(d)** Number of significant figures in multiplication is three, corresponding to the minimum number
$107.88\times0.610 = 65.8068 = 65.8$

42. **(d)** $\dfrac{97.52}{2.54} = 38.393 = 38.4$ (with least number of significant figures, 3).

43. (d) Relative density $= \dfrac{\text{Weight of body in air}}{\text{Loss of weight in water}}$

$$= \frac{5.00}{5.00 - 4.00} = \frac{5.00}{1.00}$$

$$\frac{\Delta\rho}{\rho} \times 100 = \left(\frac{0.05}{5.00} + \frac{0.05}{1.00}\right) \times 100$$

$$= (0.01 + 0.05) \times 100$$

$$= 0.06 \times 100 = 6\%$$

$\therefore$ Relative density $= 5.00 \pm 6\%$

44. (c) $\dfrac{0.2}{25} \times 100 = 0.8$

45. (a)

Level–2

1. (a) **2. (a)** **3. (c)** **4. (c)** **5. (b)**

6. (a)

7. (c) Angular displacement has unit (degree or radian) but it is dimensionless.
Note : vice-versa is not possible.

8. (c)

9. (b) $\text{Power} = \dfrac{\text{Energy}}{\text{time}}$

10. (d) Electromotive force = potential difference

$$V = \frac{W}{q} = \frac{ML^2T^{-2}}{AT} = [ML^2T^{-3}A^{-1}]$$

11. (b)

12. (a) Moment of couple = force × distance $= [M^1L^2T^{-2}]$

work = force × distance $= [M^1L^2T^{-2}]$.

13. (c) $\dfrac{eV}{T} = \dfrac{W}{T} = \dfrac{PV}{T} = R$

and $\dfrac{R}{N}$ = Boltzmann constant.

14. (b) As $\dfrac{a}{V^2} = P$

$$\therefore\ a = PV^2 = \frac{\text{dyne}}{\text{cm}^2}(\text{cm}^3)^2 = \text{dyne} \times \text{cm}^4$$

15. (a)

16. (a) Wavelength is the distance between two consecutive crests or troughs and 1 angstrom = 10^{-10}m, joule is the unit of energy. Intensity of sound is measured in decibel. Frequency is measured in hertz (Hz).

17. (c) The unit of temperature is kelvin, power is measured in watt, pressure in pascal and force in newton.

18. (c) The unit of acceleration is metre per sec^2. The unit of electric current is ampere. The unit of work done is joule. The unit of impulse is newton second.

19. (d)

20. (c)

2 Mtn

Level–1

DIRECTIONS : *This section contains multiple choice questions. Each question has 4 choices (a), (b), (c) and (d) out of which only one is correct.*

1. If a body is moving at constant speed in a circular path, its
(a) velocity is constant and its acceleration is zero
(b) velocity and acceleration are both changing direction only
(c) velocity and acceleration are both increasing
(d) velocity is constant and acceleration is changing direction

2. A graph is plotted showing the velocity of a car as a function of time. If the graph is a straight line, it means that
(a) the car started at rest
(b) acceleration was constant
(c) acceleration was increasing
(d) velocity was constant

3. If a car is traveling north on a straight road and its brakes are applied, it will
(a) have no acceleration
(b) accelerate to the south
(c) accelerate to the north
(d) accelerate either east or west

4. An object moves with a uniform velocity when
(a) the forces acting on the object are balanced
(b) there is no external force on it
(c) Both of (a) and (b)
(d) Either (a) or (b)

5. The acceleration of a car that speeds up from 12 meters per second to 30 meters per second in 15 seconds–
(a) $2.4\ m/s^2$ (b) $1.2\ m/s^2$
(c) $2\ m/s^2$ (d) $5.2\ m/s^2$

6. A particle experiences constant acceleration for 20 seconds after starting from rest. If it travels a distance s_1 in the first 10 seconds and distance s_2 in the next 10 seconds, then
(a) $s_2 = s_1$ (b) $s_2 = 2s_1$ (c) $s_2 = 3s_1$ (d) $s_2 = 4s_1$

7. Motion of an object is the change in position with respect to a reference point known as
(a) origin (b) initial position
(c) final position (d) distance

8. Displacement is the
(a) shortest distance between initial and final positions
(b) the actual distance between initial and final positions
(c) the distance traveled by the object
(d) distance traveled by the object in a unit time

9. An object has traveled 10 km in 15 minutes, its displacement will be
(a) 10 km (b) Can be zero
(c) More than 10 km (d) All of the above

10. If an object covers equal distances in equal intervals of time, it is said to be in
(a) Circular Motion (b) Uniform Motion
(c) Oscillatory Motion (d) Non-uniform Motion

11. Average velocity of an object is obtained by
(a) Dividing the total distance traveled by the total time taken
(b) Half of the sum of the initial velocity and the final velocity
(c) Both (a) and (b)
(d) None of the above

12. Negative value of acceleration signifies
(a) The velocity is increasing
(b) The velocity is decreasing
(c) The velocity remains the same
(d) The object comes to rest

13. In distance-time graphs
(a) Distance is taken along the X- axis
(b) Time is taken along the Y-axis
(c) Straight line indicates uniform motion
(d) Straight line indicates non-uniform motion

14. In velocity-time graphs
(a) Velocity is taken along the Y-axis and Time is taken along the X-axis
(b) Straight line indicates uniform acceleration
(c) Straight line parallel to x-axis indicates uniform motion
(d) All of the above

15. The equation(s) of motion can be represented as
(a) $v = u + at$ (b) $s = ut + \frac{1}{2}at^2$
(c) $2as = v^2 - u^2$ (d) All of these

16. A train travels 40 km at a uniform speed of 30 km h^{-1}. Its average speed after traveling another 40 km is 45 km h^{-1} for the whole journey. Its speed in the second half of the journey is
(a) 45 km h^{-1} (b) 90 km h^{-1}
(c) 60 km h^{-1} (d) None of these

17. A man walks on a straight road from his home to market 2.5km. away with a speed of 5 km/h. Finding the market closed, he instantly turns and walks back home with a speed of 7.5 km/h. The average speed of the man over the interval of time 0 to 40 min. is equal to –
(a) 5 km/h (b) 25/4 km/h
(c) 30/4 km/h (d) 45/8 km/h

18. A ball is dropped from a window 24 meters high. How long will it take to reach the ground ?
(a) 2.2 s (b) 1.2 s (c) 4.5 s (d) 0.2 s

19. Mohan takes 20 minutes to cover a distance of 3.2 kilometers due north on a bicycle, his velocity in kilometer/hour–
(a) 8.1 (b) 9.6 (c) 1.2 (d) 7.2

20. A pitcher throws his fastball horizontally at 42.1 meters per second.
How far does it drop before crossing the plate, 18.3 meters away?
(a) 0.8 m (b) 1.2 m (c) 2.2 m (d) 0.93 m

21. Two balls A and B of same masses are thrown from the top of the building. A, thrown upward with velocity V and B, thrown downward with velocity V, then –
(a) Velocity of A is more than B at the ground
(b) Velocity of B is more than A at the ground
(c) Both A and B strike the ground with same velocity
(d) None of these

22. A ball is released from the top of a tower of height h meters. It takes T seconds to reach the ground. What is the position of the ball in T/3 seconds –
(a) h/9 meters from the ground
(b) 7h/9 meters from the ground
(c) 8h/9 meters from the ground
(d) 17h/18 meters from the ground

23. When a bus suddenly takes a turn, the passengers are thrown outwards because of –
(a) inertia of motion (b) acceleration of motion
(c) speed of motion (d) Both (b) and (c)

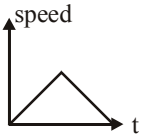
24. A thief snatches a purse and runs due west, going 6.0 meters per second. A policeman, 15 meters to the east, sees the event and gives chase. If the officer is a good sprinter, going at 8.5 meters per second, how far does he have to run to catch the thief –
(a) 12 m (b) 51 m (c) 61 m (d) 55 m

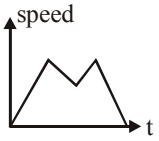
25. A car going at 24 meters per second passes a motorcycle at rest. As it passes, the motorcycle starts up, accelerating at 3.2 meters per second squared. If the motorcycle can keep up that acceleration, how long will it take for it to catch the car –
(a) 12 s (b) 14 s (c) 20 s (d) 18 s

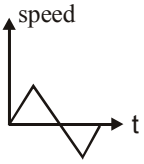
26. The initial velocity of a body is 15 m/s. If it is having an acceleration of 10 m/s^2, then the velocity of body after 10 seconds from start –
(a) 110 m/s (b) 105 m/s (c) 120 m/s (d) 115 m/s

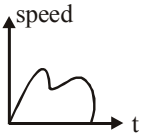
27. Which of the following can be zero, when a particle is in motion for some time?
(a) Distance (b) Displacement
(c) Speed (d) None of these

28. Which of the following speed time graphs is not possible?

(a) 

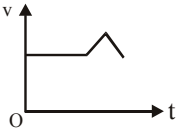
(b) 

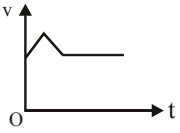
(c) 

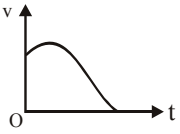
(d) 

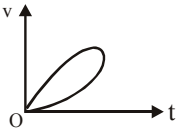
29. The numerical ratio of average velocity to average speed is
(a) always less than one (b) always equal to one
(c) always more than one (d) equal to or less than one

30. Which of the following velocity time graph is not possible?

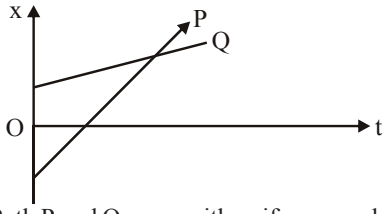
(a) 

(d) 

(c) 

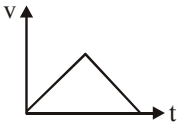
(d) 

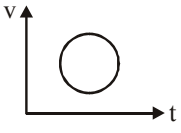
31. The fig given shows the time-displacement curve of two particles P and Q. Which of the following statement is correct?

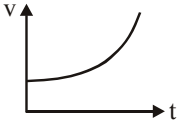


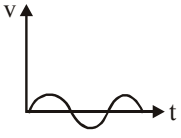
(a) Both P and Q move with uniform equal speed
(b) P is accelerated Q is retarded
(c) Both P and Q move with uniform speeds but the speed of P is more than the speed of Q
(d) Both P and Q move with uniform speeds but the speed of Q is more than the speed of P.

32. Which of the following curves do not represent motion of a body?

(a) 

(b) 

(c) 

(d) 

33. A passenger in a moving train tosses a coin. If the coin falls behind him, the train must be moving with
(a) an acceleration (b) a deceleration
(c) a uniform speed (d) any of the above

34. A body is imparted motion from rest to move in a straight line. If it is then obstructed, by an opposite force, then
(a) the body may necessarily change direction
(b) the body is sure to slow down
(c) the body will necessarily continue to move in the same direction at the same speed
(d) None of these

35. Which of the following decreases in motion along a straight line with constant retardation while the body is moving away from the origin?
(a) Speed (b) Acceleration
(c) Displacement (d) None of these

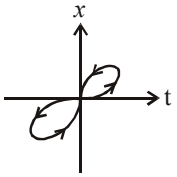
36. Which of the following is not an example of linear motion?
(a) An aeroplane moving on a straight track with increasing speed
(b) A body in uniform circular motion
(c) Wheel rotating at uniform speed on road
(d) A body rolling down an inclined plane

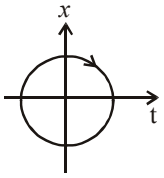
37. Which of the following changes when a particle is moving with uniform velocity?
(a) Speed (b) Velocity
(c) Acceleration (d) Position vector

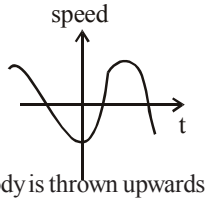
38. Which one out of the following statement is false?
(a) A body can have zero velocity and still be accelerated
(b) A body can have a constant velocity and still have a varying speed
(c) A body can have a constant speed and still have a varying velocity
(d) The direction of the velocity of a body can change when its acceleration is constant.

39. What determines the nature of the path followed by the particle
(a) speed (b) velocity
(c) acceleration (d) both (b) and (c)

40. Which of the following graph cannot possibly represent one dimensional motion of a particle?

(a) 

(b) 

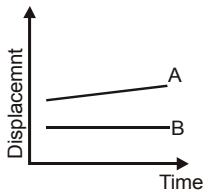
(c) 

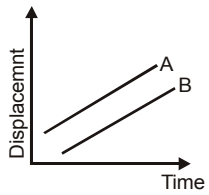
(d) All of the above

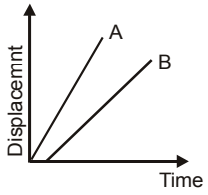
41. A body is thrown upwards and reaches its maximum height. At that position
(a) its acceleration is minimum
(b) its velocity is zero and its acceleration is also zero
(c) its velocity is zero but its acceleration is maximum
(d) its velocity is zero and its acceleration is the acceleration due to gravity.

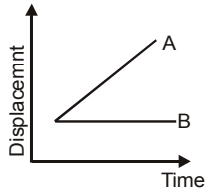
42. A train is moving towards east and a car is along north, both with same speed. The observed direction of car to the passanger in the train is
(a) east-north direction (b) west-north direction
(c) south-east direction (d) None of these

43. Which one of the following represents the time-displacement graph of two objects A and B moving with zero relative speed?

(a) 

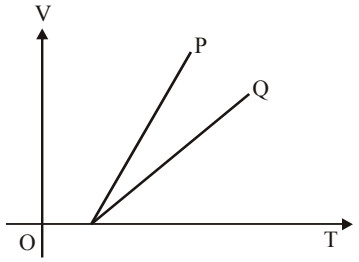
(b) 

(c) 

(d) 

44. The displacement-time graphs of two particles A and B are straight lines making angles of respectively 30º and 60º with the time axis. If the velocity of A is v_A and that of B is v_B, the value of v_A/v_B is
(a) 1/2 (b) $1/\sqrt{3}$ (c) $\sqrt{3}$ (d) 1/3

45. Figure shows the v-t graph for two particles P and Q. Which of the following statements regarding their relative motion is true? Their relative velocity is



(a) is zero
(b) is non-zero but constant
(c) continuously decreases
(d) continuously increases

46. If a body is moving at constant speed in a circular path, its
(a) velocity is constant and its acceleration is zero
(b) velocity and acceleration are both changing direction only
(c) velocity and acceleration are both increasing
(d) velocity is constant and acceleration is changing direction

47. If a car is traveling north on a straight road and its brakes are applied, it will
(a) have no acceleration
(b) accelerate to the south
(c) accelerate to the north
(d) accelerate either east or west

48. An object moves with a uniform velocity when
(a) the forces acting on the object are balanced
(b) there is no external force on it
(c) Both of (a) and (b)
(d) Either (a) or (b)

49. Friction forces act
(a) in the direction of force applied
(b) in the direction of the motion
(c) in the direction opposite to the direction of motion
(d) None of these

50. In which of the following cases, the object does not possess an acceleration or retardation when it moves in
(a) upward direction with decreasing speed
(b) downward direction with increasing speed
(c) with constant speed along circular path
(d) with constant speed along horizontal direction

51. The speed of a falling body increases continuously, this is because
(a) no force acts on it
(b) it is very light
(c) the air exert the frictional force
(d) the earth attract it

52. The effect of frictional force may be minimized by
(a) using a smooth object
(b) using a smooth plane
(c) providing a lubricant at the surface of contact
(d) All of these

53. If an object is in a state of equilibrium
(a) it is at rest
(b) it is in motion at constant velocity
(c) it is in free fall
(d) may be more than one of the above

54. If a boat is moving along at constant speed, it may be assumed that
(a) a net force is pushing it forward
(b) the sum of only vertical forces is zero
(c) the buoyant force is greater than gravity
(d) the sum of all forces is zero

55. When a motorcar makes a sharp turn at a high speed, we tend to get thrown to one side because
(a) we tend to continue in our straight line motion
(b) an unbalanced force is applied by the engine of the motorcar changes the direction of motion of the motorcar
(c) we slip to one side of the seat due to the inertia of our body
(d) All of these

56. When a bus suddenly starts, the standing passengers lean backwards in the bus. It is an example of
(a) Newton's first law
(b) Newton's second law
(c) Newton's third law
(d) None of Newton's law

57. Momentum has the same units as that of
(a) couple (b) torque
(c) impulse (d) force

58. If an object experience a net zero unbalanced force, then the body
(a) can be accelerated
(b) moves with constant velocity
(c) cannot remain at rest
(d) None of these

59. A hockey player pushes the ball on the ground. It comes to rest after travelling certain distance because
(a) the player stops pushing the ball
(b) no unbalanced force action on the wall
(c) the ball moves only when pushes
(d) the opposing force acts on the body.

60. The physical quantity which is the product of mass and velocity of a body is known as
(a) inertia (b) momentum
(c) force (d) change in momentum

61. Rate of change of momentum of an object is proportional to the
(a) balanced force applied
(b) applied unbalanced force in the direction of the force
(c) time during which the force is applied
(d) All of these

62. A moving object can come to rest only if it
(a) has a frictional force acting on it
(b) has no net force acting on it
(c) is completely isolated
(d) applies an impulse to something else

63. When a body is stationary-
(a) There is no force acting on it
(b) The force acting on it not in contact with it
(c) The combination of forces acting on it balances each other
(d) The body is in vacuum

64. A rider on horse falls back when horse starts running, all of a sudden because
(a) rider is taken back
(b) rider is suddenly afraid of falling
(c) inertia of rest keeps the upper part of body at rest while lower part of the body moves forward with the horse
(d) None of the above

65. A man getting down a running bus, falls forward because
(a) due to inertia of rest, road is left behind and man reaches forward
(b) due to inertia of motion upper part of body continues to be in motion in forward direction while feet come to rest as soon as they touch the road
(c) he leans forward as a matter of habit
(d) of the combined effect of all the three factors stated in (a), (b) and (c)

66. Swimming is possible on account of
(a) first law of motion
(b) second law of motion
(c) third law of motion
(d) newton's law of gravitation

67. A man is at rest in the middle of a pond on perfectly smooth ice. He can get himself to the shore by making use of Newton's
(a) first law (b) second law
(c) third law (d) all the laws

68. A parrot is sitting on the floor of a closed glass cage which is in a boy's hand. If the parrot starts flying with a constant speed, the boy will feel the weight of the cage as
(a) unchanged (b) reduced
(c) increased (d) nothing can be said

69. A cannon after firing recoils due to-
(a) conservation of energy
(b) backward thrust of gases produced

(c) Newton's third law of motion
(d) Newton's first law of motion

70. Newton's third law of motion leads to the law of conservation of-
(a) angular momentum (b) energy
(c) mass (d) momentum

71. The force of friction acting on a car on different roads in the increasing order of magnitude will be
(a) mud, tar, concrete and gravel roads
(b) tar, concrete, gravel and mud roads
(c) concrete, tar, gravel and mud roads
(d) gravel, mud, tar and concrete roads

72. Rockets work on the principle of conservation of
(a) energy (b) mass
(c) momentum (d) All of these

73. Motion of an object is the change in position with respect to a reference point known as
(a) origin (b) initial position
(c) final position (d) distance

74. Displacement is the
(a) shortest distance between initial and final positions
(b) the actual distance between initial and final positions
(c) the distance traveled by the object
(d) distance traveled by the object in a unit time

75. An object has traveled 10 km in 15 minutes, its displacement will be
(a) 10 km (b) Can be zero
(c) More than 10 km (d) All of the above

76. If an object covers equal distances in equal intervals of time, it is said to be in
(a) Circular Motion (b) Uniform Motion
(c) Oscillatory Motion (d) Non-uniform Motion

77. Average velocity of an object is obtained by
(a) Dividing the total distance traveled by the total time taken
(b) Half of the sum of the initial velocity and the final velocity
(c) Both (a) and (b)
(d) None of the above

78. Negative value of acceleration signifies
(a) The velocity is increasing
(b) The velocity is decreasing
(c) The velocity remains the same
(d) The object comes to rest

79. In distance-time graphs
(a) Distance is taken along the X- axis
(b) Time is taken along the Y-axis
(c) Straight line indicates uniform motion
(d) Straight line indicates non-uniform motion

80. A person is standing in an elevator. In which situation he finds his weight less than actual when –
(a) The elevator moves upward with constant acceleration.
(b) The elevator moves downward with constant acceleration
(c) The elevator moves upward with uniform velocity
(d) The elevator moves downward with uniform velocity

81. When a bus suddenly takes a turn, the passengers are thrown outwards because of –
(a) inertia of motion (b) acceleration of motion
(c) speed of motion (d) Both (b) and (c)

Level–

1. A ball is thrown vertically upward from the ground with a speed of 25.2 m/s. The ball will reach the highest point of its journey in
(a) 5.14 s (b) 3.57 s (c) 2.57 s (d) 1.29 s

2. If the distance S covered by a moving car in rectilinear motion with a speed v in time t is given by $S = vt$, then the car undergoes
(a) a uniform acceleration
(b) a non-uniform acceleration
(c) a uniform velocity
(d) a non-uniform velocity

3. An automobile travelling with a speed of 60 km/h, can apply brake to stop within a distance of 20m. If the car is going twice as fast i.e., 120 km/h, the stopping distance will be
(a) 60m (b) 40m (c) 20m (d) 80m

4. A stone thrown vertically upwards with a speed of 5 m/sec attains a height H_1. Another stone thrown upwards from the same point with a speed of 10 m/sec attains a height H_2. The correct relation between H_1 and H_2 is
(a) $H_2 = 4H_1$ (b) $H_2 = 3H_1$
(c) $H_1 = 2H_2$ (d) $H_1 = H_2$

5. A food packet is released from a helicopter rising steadily at the speed of 2 m/sec. After 2 seconds the velocity of the packet is
($g = 10\ m/sec^2$)
(a) 22 m/sec (b) 20 m/sec
(c) 18 m/sec (d) none of these

6. A stone thrown upward with a speed u from the top of the tower reaches the ground with a velocity 3u. The height of the tower is
(a) $3u^2/g$ (b) $4u^2/g$ (c) $6u^2/g$ (d) $9u^2/g$

7. A ball is dropped downwards, after 1 sec another ball is dropped downwards from the same point. What is the distance between them after 3 sec?
(a) 25m (b) 20m (c) 50m (d) 9.8m

8. A stone is thrown vertically upwards. When the particle is at a height half of its maximum height, its speed is 10m/sec, then maximum height attained by particle is ($g = 10 m/sec^2$)
(a) 8m (b) 10m (c) 15m (d) 20m

9. A body released from the top of a tower falls through half the height of the tower in 2 s. In what time shall the body fall through the height of the tower ?
(a) 4 s (b) 3.26 s (c) 3.48 s (d) 2.828 s

10. A body travels 2 m in the first two second and 2.20 m in the next 4 second with uniform deceleration. The velocity of the body at the end of 9 second is
(a) $-10\ ms^{-1}$ (b) $-0.20\ ms^{-1}$
(c) $-0.40\ ms^{-1}$ (d) $-0.80\ ms^{-1}$

11. From a 200 m high tower, one ball is thrown upwards with speed of 10 ms^{-1} and another is thrown vertically downwards at the same speeds simultaneously. The time difference of their reaching the ground will be nearest to
(a) 12 s (b) 6 s (c) 2 s (d) 1 s

12. A car travels from A to B at a speed of 20 km h^{-1} and returns at a speed of 30 km h^{-1}. The average speed of the car for the whole journey is
(a) 5 km h^{-1} (b) 24 km h^{-1}
(c) 25 km h^{-1} (d) 50 km h^{-1}

13. A man leaves his house for a cycle ride. He comes back to his house after half-an-hour after covering a distance of one km. What is his average velocity for the ride ?
(a) zero (b) 2 km h^{-1}
(c) 10 km s^{-1} (d) $\frac{1}{2}$ km s^{-1}

14. A boy moving with a velocity of 20 km h^{-1} along a straight line joining two stationary objects. According to him both objects
(a) move in the same direction with the same speed of 20 km h^{-1}
(b) move in different direction with the same speed of 20 km h^{-1}
(c) move towards him
(d) remain stationary

15. If you were to throw a ball vertically upward with an initial velocity of 50 m/s, approximately how long would it take for the ball to return to your hand? Assume air resistance is negligible.
(a) 2.5 s (b) 5.0 s (c) 7.5 s (d) 10 s

16. Two trains are each 50 m long moving parallel towards each other at speeds 10 m/s and 15 m/s respectively. After what time will they pass each other?
(a) $5\sqrt{\frac{2}{3}}$ sec (b) 4 sec
(c) 2 sec (d) 6 sec

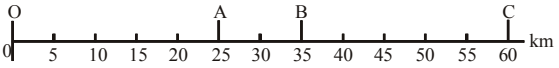
17. A passenger travels along the straight road for half the distance with velocity v_1 and the remaining half distance with velocity v_2. Then average velocity is given by
(a) $v_1 v_2$ (b) v_2^2 / v_1^2
(c) $(v_1 + v_2)/2$ (d) $2v_1v_2 / (v_1 + v_2)$

18. A bullet is fired vertically up from a 400 m tall tower with a speed 80 m/s. If g is taken as 10 m/s^2, the time taken by the bullet to reach the ground will be
(a) 8 s (b) 16 s (c) 20 s (d) 24 s

19. An object is moving with uniform acceleration a. Its initial velocity is u and after time t its velocity is v. The equation of its motion is v = u + at. The velocity (along y-axis) time (along x-axis) graph shall be a straight line
(a) passing through origin (b) with x-intercept u
(c) with y-intercept u (d) with slope u

20. A boy throws four stones of same shape, size and weight with equal speed at different initial angles with the horizontal line. If the angles are 15°, 30°, 45° and 60°, at which angle the stone will cover the maximum horizontally?
(a) 15° (b) 30°
(c) 45° (d) 60°

21. The motion of a car along a straight path is shown by the following figure:



The car starts O and reaches at A, B and C at different instants of time. During its motion from O to C and back to B, the distance covered and the magnitude of the displacement are, respectively
(a) 25 km and 60 km (b) 95 km and 35 km
(c) 60 km and 25 km (d) 85 km and 35 km

22. A brass ball is tied to a thin wire and swung so as to move uniformly in a horizontal circle. Which of the following statements in this regard is/are true?
1. The ball moves with constant velocity
2. The ball moves with constant speed
3. The ball moves with constant acceleration
4. The magnitude of the acceleration of the ball is constant

Select the correct answer using the code given below:
(a) 1 only (b) 1 and 3
(c) 1, 2 and 4 (d) 2 and 4 only

23. Which one of the following statements is not correct?
(a) If the velocity and acceleration have opposite sign, the object is slowing down
(b) If the velocity is zero at an instant, the acceleration should also be zero at that instant
(c) If the velocity is zero for a time interval; the acceleration is zero at any instant within the time interval
(d) If the position and velocity have opposite sign, the object is moving towards the origin

24. In a vacuum, a five-rupee coin, a feather of a sparrow bird and a mango are dropped simultaneously from the same height. The time taken by them to reach the bottom it t_1, t_2 and t_3 respectively. In this situation, we will observe that
(a) $t_1 > t_2 > t_3$ (b) $t_1 > t_3 > t_2$
(c) $t_3 > t_1 > t_2$ (d) $t_1 = t_2 = t_3$

25. A particle moves with uniform acceleration along a straight line from rest. The percentage increase in displacement during sixth second compared to that in fifth second is about
(a) 11% (b) 22% (c) 33% (d) 44%

HINTS & EXPLANATIONS

Level–1

1. **(b)** **2.** **(b)** **3.** **(b)**

4. **(c)** An object moves with a uniform velocity when the forces acting on the object are balanced and there is no external force on it.

5. **(b)** **6.** **(c)**

7. **(a)** Motion of an object is the change in position with respect to a reference point called origin.

8. **(a)** Displacement is the shortest distance between initial and final positions.

9. **(d)** An object has traveled 10 km in 15 minutes, its displacement will be according to the direction it has followed.

10. **(b)** If an object covers equal distances in equal intervals of time, it is said to be in uniform motion.

11. **(b)** Average velocity of an object is obtained by taking the arithmetic mean of the initial and final velocity.

12. **(b)** Negative value of acceleration signifies deceleration or in other words the velocity is decreasing.

13. **(c)** In distance-time graphs, the distance is taken along the Y- axis, Time is taken along the X-axis. Straight line indicates uniform motion.

14. **(d)** In velocity-time graphs, Velocity is taken along the Y-axis and Time is taken along the X-axis. A straight line indicates uniform acceleration and a straight line parallel to X-axis indicates uniform motion.

15. **(b)** The equations of motion are

(1) $v = u + at$

(2) $s = ut + \frac{1}{2} at^2$

(3) $2as = v^2 - u^2$

16. **(b)** Let speed of the train in later half = x, then the time taken to travel later 40 km = 40/x hours

Total time taken = 40/30 + 40/x

$$\text{Average speed} = \frac{80}{4/3 + 40x} = 45$$

Solve the equation to find value of x

17. **(d)** Aw man walks from his home to market with a speed of 5 km/h. Distance = 2.5 km and time $= \frac{d}{v} = \frac{2.5}{5} = \frac{1}{2}$ hr.

and he returns back with speed of 7.5 km/h in rest of time of 10 minutes.

$$\text{Distance} = 7.5 \times \frac{10}{60} = 1.25 \text{ km}$$

So, Average speed

$$= \frac{\text{Total distance}}{\text{Total time}} = \frac{(2.5 + 1.25) \text{ km}}{(40/60) \text{ hr}} = \frac{45}{8} \text{km/hr.}$$

18. **(a)** In free fall, the acceleration is 9.8 m/s^2, there is uniform acceleration starting from rest, so $s = \frac{1}{2}at^2$

and $t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2 \times 24\text{m}}{9.8 \text{ m/s}^2}} = 2.2 \text{ s}$

19. **(b)** The total distance moved s = 3.2 km (due north)

The total time taken t = 20 minutes

$= \frac{20}{60}$ hours $= \frac{1}{3}$ hours

The velocity of the bicycle

$$v = \frac{\text{Total distance covered}}{\text{Total time taken}} = \frac{s}{t}$$

$$v = \frac{3.2 \text{ km}}{(1/3) \text{ h}} = 9.6 \text{ km/h due north}$$

20. **(d)** The time it takes the ball to get to the plate, at constant horizontal speed, is (18.3 m)/42.1 m/s) = 0.435 s.

During that time, gravity makes it drop a distance of

$$s = \frac{1}{2}at^2 = \frac{1}{2}(9.8 \text{ m/s}^2)(0.435 \text{ s})^2 = 0.93 \text{ m}$$

21. **(c)** $v^2 = u^2 + 2gh \Rightarrow v = \sqrt{u^2 + 2gh}$

So, for both the cases velocity will be equal.

22. **(c)** $\because\ h = ut + \frac{1}{2}gt^2 \Rightarrow h = 0 + \frac{1}{2}gT^2$

After T/3 seconds, the position of ball,

$$h' = 0 + \frac{1}{2}g\left(\frac{T}{3}\right)^2 = \frac{1}{2} \times \frac{g}{9} \times T^2$$

$$h' = \frac{1}{2} \times \frac{g}{9} \times T^2 = \frac{h}{9} \text{m from top}$$

$\therefore$ Position of ball from ground $= h - \frac{h}{9} = \frac{8h}{9}$ m

23. **(a)** When a bus suddenly takes a turn, the passengers are thrown outwards because of inertia of motion.

24. **(b)** The thief runs a distance s in time t at 6.0 m/s, the policeman runs (s + 15m) in the same time, going 8.5 m/s. For both, time is distance over speed, so

$$t = \frac{s}{6.0 \text{ m/s}} = \frac{(s + 15\text{m})}{8.5 \text{ m/s}} \text{ from which } s = 36 \text{ m.}$$

The policeman runs 51m.

25. **(b)** Both vehicles travel the same distance. For the car, going at constant speed, the distance is vt, for the motorcycle, it is $\frac{1}{2}$ at^2. Then

$$s = (22 \text{ m/s})\, t = \frac{1}{2}(3.2 \text{ m/s}^2)\, t^2$$

from which t = 14s.

26. (d) The initial velocity of a body u = 15 m/s.
Acceleration of body $a = 10\ m/s^2$
and time t = 10s
If v is the velocity of body after 10s then from equation
$v = u + at$
We have $v = 15 + 10\,(10) = 15 + 100 = 115$ m/s

27. (b) Displacement may be zero because final position of the particle may coincide with its initial position.

28. (c) This is because speed can never be negative.

29. (d) From the previous question, it follows that average velocity is equal to or less than one.

30. (d) is not possible, because at a particular time t, velocity cannot have two values.

31. (c) As x – t graph is a straight line in either case, velocity of both is uniform. As the slope of x – t graph for P is greater, therefore, velocity of P is greater than that of Q.

32. (b) At a particular time, two values of velocity are not possible.

33. (a) As the coin falls behind him, force due to air must be backwards. Therefore, the train must be accelerating forward.

34. (b) The opposing force must cause retardation, due to which the body is sure to slow down.

35. (a) When a body moves along a straight line with constant retardation, its speed goes on decreasing.

36. (b) A body in uniform circular motion is moving in a plane and is two dimensional motion.

37. (d) **38. (b)** **39. (d)**

40. (d) In (a), at the same time particle has two positions which is not possible. In (b), particle has two velocities at the same time. In (c), speed is negative which is not possible.

41. (d)

42. (b)

43. (b) Relative speed = 0 when velocity of A = velocity of B
$\therefore$ displacement-time graphs of A and B must have same slope (other than zero).

44. (d) $v_A = \tan 30^\circ$ and $v_B = \tan 60^\circ$

$$\therefore \quad \frac{v_A}{v_B} = \frac{\tan 30^\circ}{\tan 60^\circ} = \frac{1/\sqrt{3}}{\sqrt{3}} = \frac{1}{3}$$

45. (d) The difference in velocities is increasing with time as both of them have more constant but different acceleration.

46. (b) **47. (b)**

48. (c) An object moves with a uniform velocity when the forces acting on the object are balanced and there is no external force on it.

49. (b) Friction forces act in the direction opposite to the direction of motion.

50. (d) **51. (d)**

52. (d) The effect of frictional force may be minimized by using a smooth object, using a smooth plane or by providing a lubricant at the surface of contact.

53. (d) **54. (d)**

55. (d) When a motorcar makes a sharp turn at a high speed, we tend to get thrown to one side because we tend to continue in our straight line motion and an unbalanced force is applied by the engine of the motorcar changes the direction of motion of the motorcar. So, we slip to one side of the seat due to the inertia of our body.

56. (a) **57. (c)** **58. (b)** **59. (d)** **60. (b)**

61. (b) Rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of the force.

62. (d) **63. (c)** **64. (c)** **65. (b)** **66. (c)** **67. (c)**

68. (a) **69. (c)** **70. (d)** **71. (c)**

72. (c) Rockets are examples of third law of motion, i.e. the law of conservation of momentum.

73. (a) Motion of an object is the change in position with respect to a reference point called origin.

74. (a) Displacement is the shortest distance between initial and final positions.

75. (d) An object has traveled 10 km in 15 minutes, its displacement will be according to the direction it has followed.

76. (b) If an object covers equal distances in equal intervals of time, it is said to be in uniform motion.

77. (b) Average velocity of an object is obtained by taking the arithmetic mean of the initial and final velocity.

78. (b) Negative value of acceleration signifies deceleration or in other words the velocity is decreasing.

79. (c) In distance-time graphs, the distance is taken along the Y- axis, Time is taken along the X-axis. Straight line indicates uniform motion.

80. (b) The elevator moves downward with constant acceleration.

81. (a) When a bus suddenly takes a turn, the passengers are thrown outwards because of inertia of motion.

Level–2

1. (c)

2. (c) As the body moves with a constant speed v along a straight line or rectilinear path hence body undergoes a uniform velocity. Here direction of the moving body is unchanged.

3. (d) Speed $v_1 = 60 \times \frac{5}{18}\ m/s = \frac{50}{3}\ m/s$

$d_1 = 20m,\ v_1' = 120 \times \frac{5}{18} = \frac{100}{3}\ m/s$

Let dceleration be a

$\therefore 0 = v_1^2 - 2ad_1$ ....(1)

or $v_1^2 = 2ad_1$

$(2v_1)^2 = 2ad_2$ ...(2)

(2) divided by (1) gives,

$4 = \frac{d_2}{d_1} \Rightarrow d_2 = 4 \times 20 = 80\,m$

4. (a) From third equation of motion $v^2 = u^2 + 2ah$

In first case initial velocity $u_1 = 5$ m/sec

final velocity $v_1 = 0$, $a = -g$

and max. height obtained is H_1, then, $H_1 = \frac{25}{2g}$

In second case $u_2 = 10$ m/sec, $v_2 = 0$, $a = -g$

and max. height is H_2 then, $H_2 = \frac{100}{2g}$.

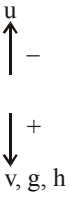
It implies that $H_2 = 4H_1$

5. (c) The food packet has an initial velocity of 2 m/sec in upward direction, therefore

$v = -u + gt$ or $v = -2 + 10 \times 2 = 18$ m /sec.

6. (b) The stone rises up till its vertical velocity is zero and again reached the top of the tower with a speed u (downward). The speed of the stone at the base is 3u.

Hence $(3u)^2 = (-u)^2 + 2gh$ or $h = \frac{4u^2}{g}$



7. (a) $S = ut + \frac{1}{2}at^2$ here $a = g$

For first body $u_1 = 0 \Rightarrow S_1 = \frac{1}{2}g \times 9$

For second body $u_2 = 0 \Rightarrow S_2 = \frac{1}{2}g \times 4$

So difference between them after 3 sec. $= S_1 - S_2$

$= \frac{1}{2} g \times 5$

If $g = 10 m/sec^2$ then $S_1 - S_2 = 25$ m.

8. (b) From third equation of motion

$v^2 = u^2 - 2gh$ $(\because a = -g)$

Given, $v = 10$ m/sec at h/2. But $v = 0$, when particle attained maximum height h.

Therefore $(10)^2 = u^2 - 2gh/2$

or $100 = 2gh - 2gh/2$ $(\because 0 = u^2 - 2gh)$

$\Rightarrow h = 10$ m

9. (d) For constant acceleration and zero initial velocity

$h \propto t^2$

$\frac{h_1}{h_2} = \frac{t_1^2}{t_2^2} \Rightarrow t_2 = \sqrt{\frac{h_2}{h_1}} t_1 = \sqrt{2} \times t_1 = \sqrt{2} \times 2\,s$

10. (b)

A to B

$2 = u \times 2 + \frac{1}{2} \times a \times 2 \times 2 \Rightarrow 1 = u + a,$

A to C

$4.20 = u \times 6 + \frac{1}{2} a \times 6 \times 6 \Rightarrow 0.7 = u + 3a$,

$2a = -0.3$ or $a = -0.15\,m\,s^{-2}$,

$u = 1 - a = (1 + 0.15)\,m\,s^{-1} = 1.15\,m\,s^{-1}$

Velocity at t = 9 sec.

$v = 1.15 - 0.15 \times 9 = 1.15 - 1.35 = -0.2\,m\,s^{-1}$

11. (c) The ball thrown upward will lose velocity in 1s. It return back to thrown point in another 1 s with the same velocity as second. Thus the difference will be 2 s.

12. (b) Average velocity $= \frac{2 \times 20 \times 30}{20 + 30} = 24\,km\,h^{-1}$

13. (a) Since displacement is zero.

14. (a) Use $\vec{v}_{AB} = \vec{v}_A - \vec{v}_B$.

15. (d) The only force acting on the ball is the force of gravity. The ball will ascend until gravity reduces its velocity to zero and then it will descend. Find the time it takes for the ball to reach its maximum height and then double the time to cover the round trip.

Using $v_{\text{at maximum height}} = v_0 + at = v_0 - gt$, we get:

$0\,m/s = 50\,m/s - (9.8\,m/s^2)\,t$

Therefore,

$t = (50\,m/s)/(9.8\,m/s^2) \sim (50\,m/s)/(10\,m/s^2) \sim 5s$

This is the time it takes the ball to reach its maximum height. The total round trip time is $2t \sim 10s$.

16. (b) Relative speed of each train with respect to each other be, $v = 10 + 15 = 25$ m/s

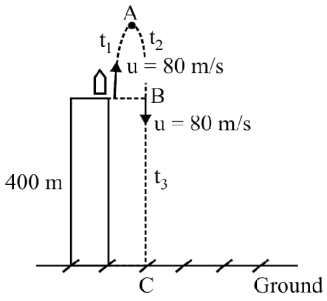
Here distance covered by each train = sum of their lengths $= 50 + 50 = 100$ m

$\therefore$ Required time $= \frac{100}{25} = 4$ sec .

17. (d) $\frac{\frac{x}{2} + \frac{x}{2}}{\frac{x}{2v_1} + \frac{x}{2v_2}} = \frac{1}{\left(\frac{v_2 + v_1}{2v_1 v_2}\right)} = \frac{2v_1 v_2}{v_1 + v_2}$

18. (c) Total time taken to reach the ground $T = t_1 + t_2 + t_3$

$u = 80$ m/s



Velocity of the bullet at point A,
$V_A = 0$ m/s.
$a = -10$ m/s
$V = u + at$
$0 = 80 - 10\,t_1$
$t_1 = 8$s
$t_2 = t_1$ (as there is no air resistance)
Calculation for t_3
Velocity of the bullet at point B,
$V_B = u = 80$ m/s
h =400m

Using $s = ut + \frac{1}{2}at^2$

$\Rightarrow \quad 400 = 80 \times t_3 + \frac{1}{2} \times 10 \times t_3^2$

$\Rightarrow \quad 5t_3^2 + 80t_3 - 400 = 0$

$\Rightarrow \quad t_3^2 + 16t_3 - 80 = 0$

$\Rightarrow \quad t_3(t_3 + 20) - 4(t_3 + 20) = 0$

$t_3 = -20$s or $t_3 = 4$s

Time cannot be negative hence neglecting $t_3 = -20$s
Total time T = 8 + 8 + 4 = 20 s

19. (c) An object is moving with uniform acceleration a. Its initial velocity is u and after time t its velocity is v. The equation of its motion is v = u + at. The velocity (along y-axis) time (along x-axis) graph shall be a straight line with y-intercept u.

20. (c) Horizontal range $R = \frac{u^2 \sin 2\theta}{g}$

For maximum horizontal range θ should be 45°

$R_{max} = \frac{u^2}{g}$ [$\because \sin 2\theta = \sin 90° = 1$]

21. (d) Distance covered by the car = OA + AB + BC + CB
= 25 + 10 + 25 + 25 = 85Km
Displacement by the car = OB = 35Km

22. (d) Velocity is the vector quantity so it gets changed as the direction changes. The ball will move with constant speed and magnitude of acceleration of the ball will also be constant.

23. (b)

24. (d) In a vacuum, a five-rupee coin, a feather of a sparrow bird and a mango are dropped simultaneously from the same height. The time taken by them to reach the bottom is t_1, t_2 and t_3 respectively. In this situation, we will observe that- $t_1 = t_2 = t_3$

25. (d) We know that $Sn^{th} = u + 1/2\ a(2n - 1)$
u = 0
S6 = 0 + 1 /2 a(2 × 6 – 1) = 11/ 2 a
S5 = 0 + 1 /2 a(2 × 65– 1) = 9 /2 a
So, the percent increase = S6th–S5th /S5th × 100
= (11/ 2 a– 9/ 2 a)/ (9/ 2 ×a) × 100
⇒ 2/ 9 × 100 ⇒ 22%

3 c s i

-1

1. By applying a force of one Newton, one can hold a body of mass
(a) 102 grams (b) 102 kg
(c) 102 mg (d) None of these

2. Friction forces act
(a) in the direction of force applied
(b) in the direction of the motion
(c) in the direction opposite to the direction of motion
(d) None of these

3. The effect of frictional force may be minimized by
(a) using a smooth object
(b) using a smooth plane
(c) providing a lubricant at the surface of contact
(d) All of these

4. When a bus suddenly starts, the standing passengers lean backwards in the bus. It is an example of
(a) Newton's first law
(b) Newton's second law
(c) Newton's third law
(d) None of Newton's law

5. Momentum has the same units as that of
(a) couple (b) torque
(c) impulse (d) force

6. When a force of newton acts on a mass of 1 kg that is free to move, the object moves with a
(a) speed of 1 m/s
(b) speed of 1 km/s
(c) acceleration of 10 m/s^2
(d) acceleration of 1m/s^2

7. If an object experience a net zero unbalanced force, then the body
(a) can be accelerated
(b) moves with constant velocity
(c) cannot remain at rest
(d) None of these

8. A hockey player pushes the ball on the ground. It comes to rest after travelling certain distance because
(a) the player stops pushing the ball
(b) no unbalanced force action on the wall
(c) the ball moves only when pushes
(d) the opposing force acts on the body.

9. The physical quantity which is the product of mass and velocity of a body is known as
(a) inertia
(b) momentum
(c) force
(d) change in momentum

10. Rate of change of momentum of an object is proportional to the
(a) balanced force applied
(b) applied unbalanced force in the direction of the force
(c) time during which the force is applied
(d) All of these

11. A book of weight 10 N is placed on a table. The force exerted by the surface of the table on the book will be
(a) Zero (b) 10 N
(c) 20 N (d) None of these

12. When a body is stationary-
(a) There is no force acting on it
(b) The force acting on it not in contact with it
(c) The combination of forces acting on it balances each other
(d) The body is in vacuum

13. A rider on horse falls back when horse starts running, all of a sudden because
(a) rider is taken back
(b) rider is suddenly afraid of falling
(c) inertia of rest keeps the upper part of body at rest while lower part of the body moves forward with the horse
(d) None of the above

14. A man getting down a running bus, falls forward because
(a) due to inertia of rest, road is left behind and man reaches forward
(b) due to inertia of motion upper part of body continues to be in motion in forward direction while feet come to rest as soon as they touch the road
(c) he leans forward as a matter of habit
(d) of the combined effect of all the three factors stated in (a), (b) and (c)

15. A force 10 N acts on a body of mass 20 kg for 10 sec. Change in its momentum is
(a) 5 kg m/s (b) 100 kg m/s
(c) 200 kg m/s (d) 1000 kg m/s

16. Swimming is possible on account of
(a) first law of motion
(b) second law of motion
(c) third law of motion
(d) newton's law of gravitation

17. A man is at rest in the middle of a pond on perfectly smooth ice. He can get himself to the shore by making use of Newton's
(a) first law (b) second law
(c) third law (d) all the laws

18. A cannon after firing recoils due to-
(a) conservation of energy
(b) backward thrust of gases produced
(c) Newton's third law of motion
(d) Newton's first law of motion

19. Newton's third law of motion leads to the law of conservation of-
(a) angular momentum (b) energy
(c) mass (d) momentum

20. Rockets work on the principle of conservation of
(a) energy (b) mass
(c) momentum (d) All of these

21. The force of friction acting on a car on different roads in the increasing order of magnitude will be
(a) mud, tar, concrete and gravel roads
(b) tar, concrete, gravel and mud roads
(c) concrete, tar, gravel and mud roads
(d) gravel, mud, tar and concrete roads

22. Inertia is that property of a body by virtue of which the body is
(a) unable to change by itself the state of rest
(b) unable to change by itself the state of uniform motion
(c) unable to change by itself the direction of motion
(d) All of the above

23. An object will continue moving uniformly when
(a) the resultant force on it is increasing continuously
(b) the resultant force is at right angles to its rotation
(c) the resultant force on it is zero
(d) the resultant force on it begins to decrease

24. We can derive Newton's
(a) second and third laws from the first law
(b) first and second laws from the third law
(c) third and first laws from the second law
(d) All the three laws are independent of each other

25. Newton's second law measures the
(a) acceleration
(b) force
(c) momentum
(d) angular momentum

26. A reference frame attached to earth cannot be an inertial frame because
(a) earth is revolving around the sun
(b) earth is rotating about its axis
(c) Newton's laws are applicable in this frame
(d) both (a) and (b)

27. China wares are wrapped in straw of paper before packing. This is the application of concept of
(a) impulse (b) momentum
(c) acceleration (d) force

28. The force of action and reaction
(a) must be of same nature
(b) must be of different nature
(c) may be of different nature
(d) may not have equal magnitude

29. A body whose momentum is constant must have constant
(a) velocity (b) force
(c) acceleration (d) All of the above

30. Pulling a roller is easier than pushing because
(a) when we pull a roller, the vertical component of the pulling force acts in the direction of weight
(b) the vertical component of the pulling force acts in the opposite direction of weight
(c) force of friction is in opposite direction
(d) it is possible in the case of roller only

31. A bullet of mass 10 gm is fired from a gun of mass 1 kg. If the recoil velocity is $5\ ms^{-1}$, the velocity of muzzle is
(a) $0.05\ ms^{-1}$ (b) $5\ ms^{-1}$
(c) $50\ ms^{-1}$ (d) $500\ ms^{-1}$

32. The direction of impulse is
(a) same as that of the net force
(b) opposite to that of the net force
(c) same as that of the final velocity
(d) same as that of the initial velocity

33. A force of 10 N acts on a body of mass 20 kg for 10 seconds. Change in its momentum is
(a) 5 kg m/s (b) 100 kg m/s
(c) 200 kg m/s (d) 1000 kg m/s

34. A machine gun of mass M fires n bullets per second. The mass and speed of each bullet is m and v respectively. The force exerted on the machine gun is
(a) zero (b) mvn
(c) Mvn (d) Mvn/m

35. A long jumper runs before jumping because he
(a) covers a greater distance
(b) maintains momentum conservation
(c) gains energy by running
(d) gains momentum

36. The resultant of force of 5N and 10N cannot be
(a) 12 N (b) 8 N
(c) 4 N (d) 5 N

37. The momentum is most closely related to
(a) force (b) impulse
(c) power (d) kinetic energy

38. Which of the following groups of forces could be in equilibrium
(a) 3N, 4N, 5 N (b) 4N, 5N, 10 N
(c) 30 N, 40 N 80N (d) 1 N, 3 N, 5 N

39. Which of the following statements about friction is true?
(a) Friction can be reduced to zero
(b) Frictional force cannot accelerate a body
(c) Frictional force is proportional to the area of contact between the two surfaces
(d) Kinetic friction is always greater than rolling friction

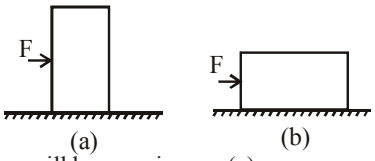
40. Which of the following is a self adjusting force?
(a) Static friction (b) Limiting friction
(c) Dynamic friction (d) Sliding friction

41. If μ_s, μ_k and μ_r are coefficients of static friction, sliding friction and rolling friction, then
(a) $\mu_s < \mu_k < \mu_f$ (b) $\mu_k < \mu_r < \mu_s$
(c) $\mu_r < \mu_k < \mu_s$ (d) $\mu_r = \mu_k = \mu_s$

42. Which of the following statements is correct, when a person walks on a rough surface?
(a) The frictional force exerted by the surface keeps him moving
(b) The force which the man exerts on the floor keeps him moving
(c) The reaction of the force which the man exerts on floor keeps him moving
(d) None of these

43. It is difficult to move a cycle with brakes on because
(a) rolling friction opposes motion on road
(b) sliding friction opposes motion on road
(c) rolling friction is more than sliding friction
(d) sliding friction is more than rolling friction

44. A rectangular block is placed on a rough horizontal surface in two different ways as shown, then



(a) friction will be more in case (a)
(b) friction will be more in case (b)
(c) friction will be equal in both the cases
(d) friction depends on the relations among its dimensions.

45. A car moving on a horizontal road may be thrown out of the road in taking a turn
(a) by the gravitational force
(b) due to the lack of proper centripetal force
(c) due to the rolling frictional force between the tyre and road
(d) due to the reaction of the ground

46. By applying a force of one Newton, one can hold a body of mass
(a) 102 grams (b) 102 kg
(c) 102 mg (d) None of these

47. The effect of frictional force may be minimized by
(a) using a smooth object
(b) using a smooth plane
(c) providing a lubricant at the surface of contact
(d) All of these

48. If an object is in a state of equilibrium
(a) it is at rest
(b) it is in motion at constant velocity
(c) it is in free fall
(d) may be more than one of the above

49. If a boat is moving along at constant speed, it may be assumed that
(a) a net force is pushing it forward
(b) the sum of only vertical forces is zero
(c) the buoyant force is greater than gravity
(d) the sum of all forces is zero

50. If A and B are two objects with masses 6 kg and 34 kg respectively, then
(a) A has more inertia than B
(b) B has more inertia than A
(c) A and B have same inertia
(d) None of the two has inertia

-

1. When a motorcar makes a sharp turn at a high speed, we tend to get thrown to one side because
(a) we tend to continue in our straight line motion
(b) an unbalanced force is applied by the engine of the motorcar changes the direction of motion of the motorcar
(c) we slip to one side of the seat due to the inertia of our body
(d) All of these

2. Law of conservation of momentum states
(a) Total momentum of two objects is unchanged or conserved by the collision
(b) Sum of momentum of the two objects before the collision is equal to the sum of momentum after the collision provided there is no external force acting on them
(c) Rate of change of momentum of the first object is equal to the rate of change of momentum of the second object during a collision
(d) All the statements are true

3. Force required in accelerating a 2 kg mass at 5 m s^{-2} will be
(a) Lesser than the force required in accelerating a 4 kg mass at 2 m s^{-2}
(b) Greater than the force required in accelerating a 4 kg mass at 2 m s^{-2}
(c) Same as the force required in accelerating a 4 kg mass at 2 m s^{-2}
(d) None of these

4. A force of 10 N gives a mass m an acceleration of 5 m s^{-2} and a mass M an acceleration of 15 ms^{-2}. If the two masses are tied together, the acceleration will become
(a) 20 m s^{-2} (b) 10 m s^{-2}
(c) 3.75 m s^{-2} (d) 2 m s^{-2}

5. A force acts for 10 s on a body of mass 10 g, after which the force ceases to act. The body travels a distance of 50 cm in the next 5 seconds. The magnitude of the applied force is
(a) 10^{-4} N (b) 100 N
(c) 10 N (d) None of these

6. Consider the following statements in respect of a jet engine and a rocket:
1. A jet engine uses the surrounding air for its oxygen supply and so is unsuitable for motion in space.
2. A rocket carries its own supply of oxygen in the gas form as a fuel.

Which of the above statement(s) is/are correct?

(a) 1 only (b) 2 only

(c) Both 1 and 2 (d) Neither 1 nor 2

7. A car is moving on a circular path and takes a turn. If R_1 and R_2 be the reaction on the inner and outer wheels respectively, then

(a) $R_1 = R_2$ (b) $R_1 < R_2$

(c) $R_1 > R_2$ (d) R_1 e" R_2

8. When a ball drops onto the floor it bounces. Why does it bounce?

(a) Newton's third law implies that for every action (drop) there is a reaction (bounce)

(b) The floor exerts a force on the ball during the impact

(c) The floor is perfectly rigid

(d) The floor heats up on impact

9. Two bodies A and B are moving with equal velocities. The mass of B is double that of A. In this context, which one of the following statements is correct?

(a) Momentum of B will be double that of A.

(b) Momentum of A will be double that of B

(c) Momentum of B will be four times that of A.

(d) Momenta of both A and B will be equal.

10. One feels heavier in a lift when the lift

(a) is going down steadily (b) just begins to go up

(c) is moving up steadily (d) descends freely

11. A force apllied on a body is represented as

$\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$

and accelerates it at 1 m/s^2. The mass of the body is

(a) 10 kg (b) $10\sqrt{2}$kg

(c) $2\sqrt{10}$kg (d) 8 kg

12. Two persons are holding a rope of negligible mass horizontally. A 20 kg mass is attached to the rope at the midpoint; as a result the rope deviates from the horizontal direction. The tension required to completely straighten the rope is ($g = 10$ m /s^2)

(a) 200 N (b) 20 N

(c) 10 N (d) infinitely large

13. When a net force acts on an object, the object will be accelerated in the direction of the force with an acceleration proportional to

(a) the force on the object

(b) the velocity of the object

(c) the mass of the object

(d) the inertia of the object

14. The rate of change of momentum of a body equal of the resultant :

(a) energy (b) power

(c) force (d) impulse

15. Newton's laws of motion do not hold good for objects

(a) at rest

(b) moving slowly

(c) moving with high velocity

(d) moving with velocity comparable to velocity of light

HINTS & EXPLANATIONS

Level-1

1. (a)

2. (b) Friction forces act in the direction opposite to the direction of motion.

3. (d) The effect of frictional force may be minimized by using a smooth object, using a smooth plane or by providing a lubricant at the surface of contact.

4. (a) **5. (c)** **6. (d)** **7. (b)**

8. (d) **9. (b)**

10. (b) Rate of change of momentum of an object is proportional to the applied unbalanced force in the direction of the force.

11. (b) **12. (c)** **13. (c)** **14. (b)**

15. (b) **16. (c)** **17. (c)** **18. (c)**

19. (d)

20. (c) Rockets are examples of third law of motion, i.e. the law of conservation of momentum.

21. (c)

22. (d) Newton' first law of motion is also called law of inertia as it defines inertia.

23. (c) The body will continue accelerating until the resultant force acting on the body becomes zero.

24. (c)

25. (b) $F = \frac{dp}{dt}$

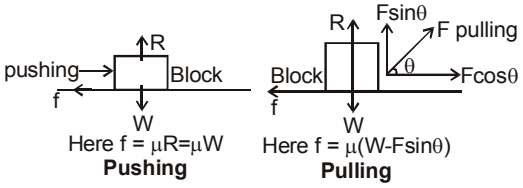
26. (d) An inertial frame of reference is one in which law of inertia holds good i.e. Newton's laws of motion are applicable equally. If earth is revolving around the sun or earth is rotating about its axis, then forces are acting on the earth and hence there will be acceleration of earth due to these forces. That is why earth can not be an inertial frame of reference.

27. (a) As a certain impulse applied for a short time will give a large force so the chinaware breaks into pieces. Therefore, chinaware is wrapped in straw of paper while packing so that the event of fall (impact) will take a longer time to reach the chinaware through straw of paper and hence the average force exerted on the chinaware is small and chances of its breaking reduce.

28. (a)

29. (b) It works on the principle of conservation of linear momentum.

30. (b)



Since we required less force in pulling in comparison of pushing it. Hence pulling is easier then pushing.

31. (d) $m_G v_G = m_B v_B \rightarrow v_B = \frac{m_G v_G}{m_B} = \frac{1 \times 5}{10 \times 10^{-3}}$

$= 500\ ms^{-1}$

32. (a)

33. (b) Change in momentum = F × t

= 10 × 10 = 100 Ns or 100 kg. m/s

34. (b) From Newton's second law, the total external applied force on the body is equal to the time rate change of momentum of the body.

$$F = \frac{dp}{dt} = \frac{m(v_2 - v_1)}{t} \quad \text{here } v_1 = 0,\ v_2 = v$$

$$\text{so } F = \frac{(mv)}{1/n} = mvn$$

35. (b) A long jumper runs before jumping to maintain momentum. This helps in jumping higher and longer because of inertia of motion gained due to the motion.

36. (c) **37. (b)** **38. (a)**

39. (d) $\mu_{static} > \mu_{kinetic} > \mu_{rolling}$

40. (a) Static friction is a self adjusting force in magnitude and direction.

41. (c) $\mu_s > \mu_k > \mu_r$

42. (c) When the men push the rough surface on walking, then surface (from Newton' third Law) applies reaction force in forward direction. It occurs because there is friction between men & surface. If surface is frictionless (such as ice), then it is very difficult to move on it.

43. (d) When brakes are on, the wheels of the cycle will slide on the road instead of rolling there. It means the sliding friction will come into play instead of rolling friction. The value of sliding friction is more than that of rolling friction.

44. (c) **45. (b)** **46. (a)**

47. (d) The effect of frictional force may be minimized by using a smooth object, using a smooth plane or by providing a lubricant at the surface of contact.

48. (d) **49. (d)** **50. (b)**

Level-2

1. (d) When a motorcar makes a sharp turn at a high speed, we tend to get thrown to one side because we tend to continue in our straight line motion and an unbalanced force is applied by the engine of the motorcar changes the direction of motion of the motorcar. So, we slip to one side of the seat due to the inertia of our body.

2. (d) Law of conservation of momentum can be defined in any of these three ways.

3. (b) Compare using the formula, F = ma.

4. (c) Acceleration on combination of two masses

$= F/(m_1 + m_2)$

5. **(c)**

6. **(c)** In respect of a jet engine and a rocket, both the given statements are correct.

7. **(b)** It has been calculated in the theory of the chapter i.e.,

$$R_1 = \frac{mg}{2}\left(1 - \frac{v^2 h}{rga}\right),$$

and $R_2 = \frac{mg}{2}\left(1 + \frac{v^2 h}{rga}\right)$, so $R_1 < R_2$.

8. **(b)** When a ball drops on to the floor then floor exerts a force for small time which is equal to change in momentum of the ball.

9. **(a)** As we know

Momentum $P = mv$

Since, $V_A = V_B = V$, and $m_0 = 2m_A$

for A, $P_A = m_A v_A$

for B $P_B = (2m_A)\, v_A$

$P_B = 2P_A$

10. **(b)** One feels heavier in a lift when the lift just begins to go up because our body gains inertia from the position of rest and pushes up against the gravity so here the weight becomes zero and our mass makes us feel heavier.

11. **(b)** $\vec{F} = 6\hat{1} - 8\hat{j} + 10\hat{k}$

$|\vec{F}| = \sqrt{(6)^2 + (-8)^2 + (10)^2}$

$= \sqrt{36 + 64 + 100} = 10\sqrt{2}\ \text{N}$

$|\vec{a}| = 1\ \text{m/s}^2$

using $F = ma$

$\Rightarrow 10\sqrt{2} = m \times 1$

$m = 10\sqrt{2}\ \text{kg}$

12. **(d)** Let T be the tension in the rope: $2T\cos\theta = mg$

Where $\theta = 90°$

$T = mg/2\cos 90$

$\cos 90 = 0$

$So = mg\ 0 = \infty$

$T = \infty$ Hence tension will be infinite.

13. **(a)** According to Newton's second laws of motion the external force acting on a body is directly proportional to the rate of change of linear momentum.i.e.

$$F \propto \frac{dp}{dt} \quad \text{or} \quad F = Kma = ma\ [\text{as } K = 1]$$

14. **(c)** Newton's 2nd Law - The rate of Change of momentum always acts in the direction of resultant force acting on a body $\Rightarrow$ (F = ma) (where m = mass; a = aceeleration)

15. **(d)** Newton's laws of motion do not hold good for objects moving with velocity comparable to velocity of light because it does not follow it on this level.

4 y P

1

1. Which is not a unit of energy?
(a) Watt second (b) Kilo watt hour
(c) Watt (d) Joule

2. 1 kilowatt hour is equal to
(a) 1 joule (b) 100 joule
(c) 36 joule (d) 3.6×10^3 kilo joule

3. A stone of mass 1 kg is raised through 1m height
(a) The loss of gravitational potential energy by the stone is 1 joule
(b) The gain of gravitational potential energy by the stone is 1 joule
(c) The loss of gravitational potential energy is 9.8 joule
(d) The gain of gravitational potential energy is 9.8 joule

4. Scientific concept of work suggest that a work is said to be done if
(a) a force acts on an object
(b) the object must be displaced
(c) energy must be consumed
(d) Both (a) and (b)

5. The kinetic energy of a body will become eight times if –
(a) its mass is made four times
(b) its velocity is made four times
(c) both the mass and velocity are doubled
(d) both the mass and velocity are made four times

6. For a body falling freely under gravity from a height
(a) only the potential energy goes on increasing
(b) only the kinetic energy goes on increasing
(c) both kinetic energy as well as potential energy go on increasing
(d) the kinetic energy goes on increasing while potential energy goes on decreasing

7. Work done is defined as
(a) product of force and displacement
(b) distance through which the object is moved
(c) mass of the object getting displaced
(d) product of force and mass

8. The kinetic energy acquired by a body of mass 'm' after travelling a fixed distance from rest under the action of a constant force is
(a) directly proportional to mass m
(b) inversely proportional to mass m
(c) inversely proportional to mass $m^{1/2}$
(d) independent of mass m

9. If a force F is applied on a body and it moves with velocity v, the power will be –
(a) Fv (b) F/v
(c) Fv^2 (d) F/v^2

10. The kinetic energy of a body becomes twice its initial value. The new momentum of the body will be
(a) 2 times (b) $\sqrt{2}$ times
(c) 4 times (d) unchanged

11. Unit of work done is
(a) Joule (b) Newton meter
(c) Calorie (d) Both (a) and (b)

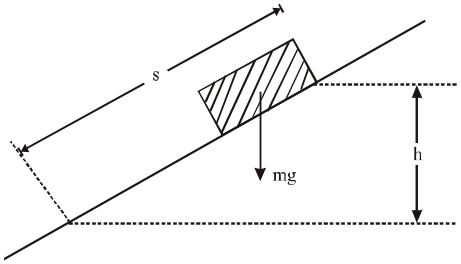
12. Kinetic energy of a body moving with speed 10 m/s is 30J. If its speed becomes 30 m/s, its kinetic energy will be
(a) 10 J (b) 90 J
(c) 180 J (d) 270 J

13. When you compress a coil spring you do work on it. The elastic potential energy
(a) increases (b) decreases
(c) disappears (d) remains the same

14. No work is done when
(a) a nail is plugged into a wooden board
(b) a box is pushed along a horizontal floor
(c) there is no component of force parallel to the direction of motion
(d) there is no component of force normal to the direction of force

15. Work done by a force can be
(a) only positive
(b) only negative
(c) both positive and negative
(d) None of these

16. The work done against gravity in moving the block a distance s up the slope is



(a) mh (b) mgs
(c) ms (d) mgh

17. Potential energy of your body is minimum when
(a) you are standing
(b) you are sitting on a chair
(c) you are sitting on the ground
(d) you lie down on the ground

18. A body of mass 2 kg is dropped from a height of 1 m. Its kinetic energy as it touches the ground is
(a) 19.6 N (b) 19.6 J
(c) 19.6 kg (d) 19.6 m

19. Negative value of work done indicates that
(a) force and displacement are in the same direction
(b) more than one force is acting on the object
(c) displacement and force are in opposite directions
(d) Both (b) and (c)

20. Work done is zero/when
(a) force and displacement of the body are in the same direction
(b) force and displacement of the body are in the opposite direction
(c) force acting on the body is perpendicular to the direction of the displacement of the body
(d) None of these

21. The energy of 4900 J was expanded in lifting a 50 kg mass. The mass was raised to a height of –
(a) 10 m (b) 98 m
(c) 960 m (d) 245000 m

22. When a stone is thrown upward to a certain height, it possesses
(a) potential energy (b) kinetic energy
(c) wind energy (d) sound energy

23. Capacity of doing work is termed as
(a) pressure (b) energy
(c) force (d) displacement

24. A fast wind can turn the blades of a windmill because it possesses –
(a) potential energy (b) kinetic energy
(c) chemical energy (d) heat energy

25. If a stone of mass m falls a vertical distance d, the decrease in gravitational potential energy is –
(a) mg/d (b) $md^2/2$
(c) mgd (d) md/g

26. A block of weight W is pulled a distance ℓ along a horizontal table. The work done by the weight is –
(a) $W\ell$ (b) 0
(c) $Wg\ell$ (d) $W\ell/g$

27. Unit of energy is
(a) same as the unit of work
(b) joule
(c) Both (a) and (b)
(d) Neither (a) nor (b)

28. The proper care and maintenance of machines require
(a) to make them good rooking
(b) for preserving them for future
(c) for their efficient and longer use
(d) None of these

29. Solar cookers are used
(a) to cook our food
(b) in artificial satellites
(c) converting into electrical energy
(d) in drying clothes and other materials

30. What is the sign of the work done by gravity on a man standing on a platform?
(a) Zero
(b) Positive
(c) Negative
(d) Depends on the particular situation

31. A body at rest can have –
(a) speed (b) energy
(c) momentum (d) velocity

32. What is the sign of the work performed on an object in uniform circular motion?
(a) Zero
(b) Positive
(c) Negative
(d) Depends on the particular situation

33. A constant force of 10 N causes a box to move at a constant speed of 2 m/s. How much work is done in 10 seconds?
(a) 200 J (b) 50 J
(c) 10 J (d) 2 J

34. An object of 2 kg is moving with a velocity of 5 m/s. If its velocity is doubled, the kinetic energy will become
(a) 100 J (b) 25 J
(c) 200 J (d) 2.5 J

35. A mass is kept stationary by an external force. All of the following are true except –
(a) the point of application of the force does not move
(b) no work is done on the mass
(c) there is no net force on the mass
(d) the external force may perform work on the mass

36. The sum of the change in kinetic and potential energy is always
(a) zero (b) positive
(c) negative (d) None of the above

37. A man of a mass 80 kg runs up a staircase in 12 seconds. Another man B of mass 60 kg runs up the same staircase in 11 seconds. The ratio of powers of A and B is –
(a) 11 : 12 (b) 11 : 9
(c) 12 : 11 (d) 9 : 11

38. A lorry and a car moving with the same K.E. are brought to rest by applying the same retarding force, then –
(a) lorry will come to rest in a shorter distance
(b) car will come to rest in a shorter distance
(c) both come to rest in a same distance
(d) None of the above

39. A weight-lifter lifts 200 kg from the ground to a height of 2 metre in 9 second. The average power generated by the man is
(a) 15680 W (b) 3920 W
(c) 1960 W (d) 980 W

40. Gravitational potential energy of an object will
(a) increase by increasing the path along which the object is moved
(b) decrease by increasing the path along which the object is moved
(c) not effected by changing the path, provided the overall height is same
(d) None of these

41. Total mechanical energy of an object is
(a) Potential energy + Kinetic energy = Constant
(b) $mgh + \frac{1}{2} mv^2$ = constant
(c) Both (a) and (b)
(d) None of these

42. Rate of doing work is termed as
(a) force (b) mechanical energy
(c) power (d) momentum

43. 1 kilowatt = -----
(a) 1000 W (b) 1000 J s^{-1}
(c) 1000 N m s^{-1} (d) All of these

44. Commercial unit of power is kilowatt-hour (kW h)
(a) 1 kW h = 3.6×10^6 J
(b) 1 kW h is the energy consumed in one hour at the rate of 1000 J s^{-1}
(c) 1 kW h = 1 unit of electrical energy
(d) All these statements are correct

45. An electrical appliance of 500 W is used for 5 hours per day. Energy consumed in 30 days will be
(a) 2.5 kW h (b) 25 kW h
(c) 75 kW h (d) None of these

46. When a freely falling object hits the ground, its kinetic energy is
(a) Converted into heat energy
(b) Used to form a crater in the ground
(c) Collides and then rebounds
(d) Any of the three are possible

47. A man pushes a wall and fails to displace it. he does
(a) negative work
(b) positive but not maximum work
(c) no work at all
(d) Maximum work

48. If force and displacement of particle in direction of force are doubled. Work would be
(a) double (b) four time
(c) half (d) 1/4 times

49. Which of the following force(s) is/are non-conservative?
(a) Frictional force (b) Spring force
(c) Elastic force (d) All of these

50. The energy stored in wounded spring watch is
(a) K.E. (b) P.E.
(c) heat energy (d) chemical energy

51. Which is not a unit of energy?
(a) Watt second (b) Kilo watt hour
(c) Watt (d) Joule

52. 1 kilowatt hour is equal to
(a) 1 joule (b) 100 joule
(c) 36 joule (d) 3.6×10^3 kilo joule

53. A stone of mass 1 kg is raised through 1m height
(a) The loss of gravitational potential energy by the stone is 1 joule
(b) The gain of gravitational potential energy by the stone is 1 joule
(c) The loss of gravitational potential energy is 9.8 joule
(d) The gain of gravitational potential energy is 9.8 joule

54. Scientific concept of work suggest that a work is said to be done if
(a) a force acts on an object
(b) the object must be displaced
(c) energy must be consumed
(d) Both (a) and (b)

55. The kinetic energy of a body will become eight times if –
(a) its mass is made four times
(b) its velocity is made four times
(c) both the mass and velocity are doubled
(d) both the mass and velocity are made four times

56. For a body falling freely under gravity from a height
(a) only the potential energy goes on increasing
(b) only the kinetic energy goes on increasing
(c) both kinetic energy as well as potential energy go on increasing
(d) the kinetic energy goes on increasing while potential energy goes on decreasing

57. Work done is defined as
(a) product of force and displacement
(b) distance through which the object is moved
(c) mass of the object getting displaced
(d) product of force and mass

58. The kinetic energy acquired by a body of mass 'm' after travelling a fixed distance from rest under the action of a constant force is
(a) directly proportional to mass m
(b) inversely proportional to mass m
(c) inversely proportional to mass $m^{1/2}$
(d) independent of mass m

59. If a force F is applied on a body and it moves with velocity v, the power will be –
(a) Fv (b) F/v
(c) Fv^2 (d) F/v^2

60. The kinetic energy of a body becomes twice its initial value. The new momentum of the body will be
(a) 2 times (b) $\sqrt{2}$ times
(c) 4 times (d) unchanged

61. Unit of work done is
(a) Joule (b) Newton meter
(c) Calorie (d) Both (a) and (b)

62. Kinetic energy of a body moving with speed 10 m/s is 30J. If its speed becomes 30 m/s, its kinetic energy will be
(a) 10 J (b) 90 J
(c) 180 J (d) 270 J

63. When you compress a coil spring you do work on it. The elastic potential energy
(a) increases
(b) decreases
(c) disappears
(d) remains the same

64. No work is done when
(a) a nail is plugged into a wooden board
(b) a box is pushed along a horizontal floor
(c) there is no component of force parallel to the direction of motion
(d) there is no component of force normal to the direction of force

65. Work done by a force can be
(a) only positive
(b) only negative
(c) both positive and negative
(d) None of these

66. Potential energy of your body is minimum when
(a) you are standing
(b) you are sitting on a chair
(c) you are sitting on the ground
(d) you lie down on the ground

67. A body of mass 2 kg is dropped from a height of 1 m. Its kinetic energy as it touches the ground is
(a) 19.6 N (b) 19.6 J
(c) 19.6 kg (d) 19.6 m

68. Negative value of work done indicates that
(a) force and displacement are in the same direction
(b) more than one force is acting on the object
(c) displacement and force are in opposite directions
(d) Both (b) and (c)

69. Work done is zero/when
(a) force and displacement of the body are in the same direction
(b) force and displacement of the body are in the opposite direction
(c) force acting on the body is perpendicular to the direction of the displacement of the body
(d) None of these

70. When a stone is thrown upward to a certain height, it possesses
(a) potential energy (b) kinetic energy
(c) wind energy (d) sound energy

71. Capacity of doing work is termed as
(a) pressure (b) energy
(c) force (d) displacement

72. A fast wind can turn the blades of a windmill because it possesses –
(a) potential energy (b) kinetic energy
(c) chemical energy (d) heat energy

73. If a stone of mass m falls a vertical distance d, the decrease in gravitational potential energy is –
(a) mg/d (b) $md^2/2$
(c) mgd (d) md/g

74. A block of weight W is pulled a distance ℓ along a horizontal table. The work done by the weight is –
(a) $W\ell$ (b) 0
(c) $Wg\ell$ (d) $W\ell/g$

75. Unit of energy is
(a) same as the unit of work (b) joule
(c) Both (a) and (b) (d) Neither (a) nor (b)

76. The proper care and maintenance of machines require
(a) to make them good rooking
(b) for preserving them for future
(c) for their efficient and longer use
(d) None of these

77. Solar cookers are used
(a) to cook our food
(b) in artificial satellites
(c) converting into electrical energy
(d) in drying clothes and other materials

78. What is the sign of the work done by gravity on a man standing on a platform?
(a) Zero
(b) Positive
(c) Negative
(d) Depends on the particular situation

79. A body at rest can have –
(a) speed (b) energy
(c) momentum (d) velocity

80. What is the sign of the work performed on an object in uniform circular motion?
(a) Zero
(b) Positive
(c) Negative
(d) Depends on the particular situation

81. An object of 2 kg is moving with a velocity of 5 m/s. If its velocity is doubled, the kinetic energy will become
(a) 100 J (b) 25 J
(c) 200 J (d) 2.5 J

82. A mass is kept stationary by an external force. All of the following are true except –
(a) the point of application of the force does not move
(b) no work is done on the mass
(c) there is no net force on the mass
(d) the external force may perform work on the mass

83. A bird flying in the sky has –
(a) K.E. only (b) P.E. only
(c) neither K.E. nor P.E. (d) both K.E. and P.E.

84. The sum of the change in kinetic and potential energy is always
(a) zero (b) positive
(c) negative (d) None of the above

85. A lorry and a car moving with the same K.E. are brought to rest by applying the same retarding force, then –
(a) lorry will come to rest in a shorter distance
(b) car will come to rest in a shorter distance
(c) both come to rest in a same distance
(d) None of the above

86. Gravitational potential energy of an object will
(a) increase by increasing the path along which the object is moved
(b) decrease by increasing the path along which the object is moved
(c) not effected by changing the path, provided the overall height is same
(d) None of these

87. Total mechanical energy of an object is
(a) Potential energy + Kinetic energy = Constant
(b) $mgh + \frac{1}{2} mv^2 = \text{constant}$
(c) Both (a) and (b)
(d) None of these

88. Rate of doing work is termed as
(a) force (b) mechanical energy
(c) power (d) momentum

89. 1 kilowatt = -----
(a) 1000 W (b) 1000 J s^{-1}
(c) 1000 N m s^{-1} (d) All of these

90. Commercial unit of power is kilowatt-hour (kW h)
(a) 1 kWh = 3.6×10^6 J
(b) 1 kW h is the energy consumed in one hour at the rate of 1000 J s^{-1}
(c) 1 kW h = 1 unit of electrical energy
(d) All these statements are correct

91. An electrical appliance of 500 W is used for 5 hours per day. Energy consumed in 30 days will be
(a) 2.5 kW h (b) 25 kW h
(c) 75 kW h (d) None of these

92. Sun is said to be the ultimate source of energy. Solar energy gets transformed into
(a) chemical energy during photosynthesis
(b) heat energy in drying food grains
(c) electrical energy in solar cells
(d) All of these

93. The potential energy of a freely falling object decreases progressively.
(a) The law of conservation of energy is violated
(b) Potential energy gets converted into kinetic energy progressively
(c) Sum of Potential Energy and Kinetic Energy at any point during the free fall remains constant
(d) Both (b) and (c)

94. When a freely falling object hits the ground, its kinetic energy is
(a) Converted into heat energy
(b) Used to form a crater in the ground
(c) Collides and then rebounds
(d) Any of the three are possible

95. If velocity of a body is twice of previous velocity, then kinetic energy will become –
(a) 2 times (b) 1/2 times
(c) 4 times (d) 1 times

96. If the K.E. of a body is increased by 300%, its momentum will increase by –
(a) 100% (b) 150%
(c) $\sqrt{300}\%$ (d) 175%

---

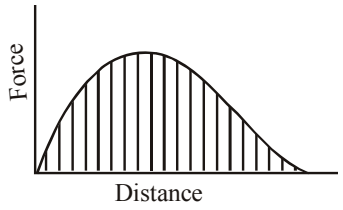
1. Sun is said to be the ultimate source of energy. Solar energy gets transformed into
(a) chemical energy during photosynthesis
(b) heat energy in drying food grains
(c) electrical energy in solar cells
(d) All of these

2. The potential energy of a freely falling object decreases progressively.
(a) The law of conservation of energy is violated
(b) Potential energy gets converted into kinetic energy progressively
(c) Sum of Potential Energy and Kinetic Energy at any point during the free fall remains constant
(d) Both (b) and (c)

3. If velocity of a body is twice of previous velocity, then kinetic energy will become –
(a) 2 times (b) 1/2 times
(c) 4 times (d) 1 times

4. If the K.E. of a body is increased by 300%, its momentum will increase by –
(a) 100% (b) 150%
(c) $\sqrt{300}\%$ (d) 175%

5. Which one of the following physical quantities is represented by the shaded area in the given graph?



(a) Torque (b) Impulse
(c) Power (d) Work done

6. Two springs have their force constant as k_1 and k_2 ($k_1 > k_2$). When they are stretched by the same force
(a) no work is done in case of both the springs.
(b) equal work is done in case of both the springs
(c) more work is done in case of second spring
(d) more work is done in case of first spring.

7. A bullet is fired from a rifle. If rifle recoils freely, then K.E. of the rifle is
(a) less than that of the bullet
(b) more than that of the bullet
(c) same as that of the bullet
(d) equal or less than that of the bullet

8. A light and a heavy body have equal momentum. Which one has greater K.E.?
(a) The light body (b) Both have equal K.E.
(c) The heavy body (d) Data given is incomplete

9. Johnny and his sister Jane race up a hill. Johnny weighs twice as much as jane and takes twice as long as jane to reach the top . Compared to Jane
(a) Johnny did more work and delivered more power.
(b) Johnny did more work and delivered the same amount of power.
(c) Johnny did more work and delivered less power
(d) Johnny did less work and johnny delivered less power.

10. The engine of a vehicle delivers constant power. If the vehicle is moving up the inclined plane then, its velocity,
(a) must remain constant
(b) must increase
(c) must decrease
(d) may increase, decrease or remain same.

11. A body has a free fall from a height of 20 m. After falling through a distance of 5 m, the body would
(a) lose one-fourth of its total energy
(b) lose one-fourth of its potential energy
(c) gain one-fourth of its potential energy
(d) gain three-fourth of its total energy

12. An object is raised to a height of 3 m from the ground. It is then allowed to fall on to a table 1 m high from ground level. In this context, which one among the following statements is correct ?
(a) Its potential energy decreases by two-thirds its original value of total energy.
(b) Its potential energy decreases by one-third its original value of total energy.
(c) Its kinetic energy increases by two-thirds, while potential energy increases by one-third.
(d) Its kinetic energy increases by one-third, while potential energy decreases by one-third.

13. A body is falling freely under the action of gravity alone in vacuum. Which one of the following remains constant during the fall?
(a) Potential energy (b) Kinetic energy
(c) Total linear momentum (d) Total mechanical energy

14. Consider the following statements. Work is not done, when:
1. a man is walking on a horizontal road.
2. a man is climbing up a hill.
3. a man with a load on his head is walking on a horizontal road.
4. moon is revolving round the earth.

Which of the statements given above are correct?
(a) 1 and 3 only (b) 1 and 4 only
(c) 2, 3 and 4 (d) 1, 3 and 4

15. Consider the following statements :
(1) A light and a heavy body, having equal momenta, have equal kinetic energies.
(2) The total energy of a body in motion is equal to the work it can do in being brought to rest.
(3) A body cannot have momentum when its energy is zero.

Which of these statements is/are correct?
(a) (1) and (2) (b) (2) and (3)
(c) Only (2) (d) Only (3)

16. Two bodies A and B having masses m and 4m respectively are moving with equal linear momentum. The ratio of kinetic energies between A and B is
(a) 1 : 4 (b) 4 : 1
(c) 1 : 1 (d) 1 : 2

17. Two cars A and B have masses m_A and m_B respectively, with $m_A > m_B$. Both the cars are moving in the same direction with equal kinetic energy. If equal braking force is applied on both, then before coming to rest
(a) A will cover a greater distance
(b) B will cover a greater distance
(c) both will cover the same distance
(d) distance covered by them will depend on their respective velocities

18. A body is thrown vertically upwards and then falls back on the ground. Its potential energy is maximum
(a) on the ground
(b) at the maximum height
(c) during the return journey
(d) both on the ground and at the maximum height

19. How is the kinetic energy of a moving object affected if the net work done on it is positive?
(a) Decrease (b) Increases
(c) Remains constant (d) Becomes zero

20. Two balls, *A* and *B* are thrown simultaneously, *A* vertically upward with a speed of 20 m/s from the ground and *B* vertically downward from a height of 40 m with the same speed and along the same line of motion. At what points do the two balls collide by taking acceleration due to gravity as 9.8 m/s^2?
(a) The balls will collide after 3s at a height of 30.2 m from the ground
(b) The balls will collide after 2s at a height of 20.1 m from the ground.
(c) The balls will collide after 1s at a height of 15.1 m from the ground
(d) The balls will collide after 5s at a height of 20m from the ground

HINTS & EXPLANATIONS

Level–1

1. (c) **2.** (d) **3.** (d)
4. (d) Scientific concept of work suggest that a work is said to be done if a force acts on an object and the object gets displaced.
5. (c) **6.** (d)
7. (a) Work done is defined as the product of force and displacement.
8. (d) **9.** (a) **10.** (b)
11. (d) Unit of work done is Joule or Newton meter.
12. (d) **13.** (a) **14.** (d)
15. (b) Work done by a force can be both negative and positive.
16. (d) **17.** (d) **18.** (b)
19. (d) Negative value of work indicates that more than one force is acting on the object. The displacement and force are in opposite directions.
20. (c) **21.** (a) **22.** (a)
23. (b) Energy is the capacity of doing work.
24. (a) **25.** (c) **26.** (b)
27. (c) Unit of energy is same as the unit of work, i.e. Joule.
28. (c) **29.** (a) **30.** (a) **31.** (b)
32. (a) **33.** (a) **34.** (b) **35.** (d)
36. (a) **37.** (b) **38.** (c) **39.** (d)
40. (c) The gravitational potential energy is not affected by the path followed provided the overall height is same.
41. (c) Mechanical energy = Potential energy + Kinetic energy.
42. (c) Rate of doing work is called power.
43. (d) 1 kilowatt = 1000 W = 1000 J s^{-1} = 1000 N m s^{-1}.
44. (d) 1 kW h = 3.6×10^6 J; 1 kW h is the energy consumed in one hour at the rate of 1000 Js^{-1}. 1 kW h is commonly referred to as a unit of electrical energy.
45. (c) Energy consumed = Work done = 0.5 kW × 5 hours × 30 days = 75 kW h.
46. (c) The change in momentum on collision is likely to make the object rebound. The momentum of the object can cause a crater in the ground. The kinetic energy will be converted into heat energy.
47. (c) **48.** (b) **49.** (a)
50. (b) The energy stored in spring in the form of elastic potential energy. i.e., $(P.E)_{elastic} = \frac{1}{2}kx^2$
Where x is compression or elongation of spring & k is spring constant.
51. (c) **52.** (d) **53.** (d)
54. (d) Scientific concept of work suggest that a work is said to be done if a force acts on an object and the object gets displaced.
55. (c) **56.** (d)
57. (a) Work done is defined as the product of force and displacement.
58. (d) **59.** (a) **60.** (b)
61. (d) Unit of work done is Joule or Newton meter.
62. (d) **63.** (a) **64.** (d)
65. (c) Work done by a force can be both negative and positive.
66. (d) **67.** (b)
68. (d) Negative value of work indicates that more than one force is acting on the object. The displacement and force are in opposite directions.
69. (c) **70.** (a)
71. (b) Energy is the capacity of doing work.
72. (a) **73.** (c) **74.** (b)
75. (c) Unit of energy is same as the unit of work, i.e. Joule.
76. (c) **77.** (a) **78.** (a) **79.** (b) **80.** (a)
81. (a) **82.** (d) **83.** (d) **84.** (a) **85.** (c)
86. (c) The gravitational potential energy is not affected by the path followed provided the overall height is same.
87. (c) Mechanical energy = Potential energy + Kinetic energy.
88. (c) Rate of doing work is called power.
89. (d) 1 kilowatt = 1000 W = 1000 J s^{-1} = 1000 N m s^{-1}.
90. (d) 1 kW h = 3.6×10^6 J; 1 kW h is the energy consumed in one hour at the rate of 1000 Js^{-1}. 1 kW h is commonly referred to as a unit of electrical energy.
91. (c) Energy consumed = Work done = 0.5 kW × 5 hours × 30 days = 75 kW h.
92. (d) Solar energy can be transformed into chemical, electrical, heat or mechanical energy by using suitable equipments.
93. (d) Potential energy gets converted into kinetic energy progressively and the sum of potential energy and kinetic energy at any point during the free fall remains constant.
94. (c) The change in momentum on collision is likely to make the object rebound. The momentum of the object can cause a crater in the ground. The kinetic energy will be converted into heat energy.
95. (c) Kinetic energy = $\frac{1}{2}mv^2$ $\quad \therefore$ K.E. $\propto v^2$
If velocity is doubled then kinetic energy will become four times.
96. (a) Let initial kinetic energy, $E_1 = E$
Final kinetic energy, $E_2 = E + 300\%$ of $E = 4E$

$$\text{As } p \propto \sqrt{E} \Rightarrow \frac{p_2}{p_1} = \sqrt{\frac{E_2}{E_1}} = \sqrt{\frac{4E}{E}} = 2 \Rightarrow p_2 = 2p_1$$

$\Rightarrow p_2 = p_1 + 100\%$ of p_1
i.e. momentum will increase by 100%.

Level–2

1. **(d)** Solar energy can be transformed into chemical, electrical, heat or mechanical energy by using suitable equipments.

2. **(d)** Potential energy gets converted into kinetic energy progressively and the sum of potential energy and kinetic energy at any point during the free fall remains constant.

3. **(c)** Kinetic energy $= \frac{1}{2}mv^2 \quad \therefore \text{ K.E.} \propto v^2$

If velocity is doubled then kinetic energy will become four times.

4. **(a)** Let initial kinetic energy, $E_1 = E$

Final kinetic energy, $E_2 = E + 300\% \text{ of } E = 4E$

$$\text{As } p \propto \sqrt{E} \Rightarrow \frac{p_2}{p_1} = \sqrt{\frac{E_2}{E_1}} = \sqrt{\frac{4E}{E}} = 2 \Rightarrow p_2 = 2p_1$$

$$\Rightarrow p_2 = p_1 + 100\% \text{ of } p_1$$

i.e. momentum will increase by 100%.

5. **(d)** Work done $= \int F dx$

6. **(c)** From Hooke's law

$F \propto x \Rightarrow F = kx.$, where k is spring constant

Since force is same in stretching for both spring so

$F = k_1x_1 = k_2x_2 \Rightarrow x_1 < x_2$ because $k_1 > k_2$

so work done in case of first spring is $W_1 = \frac{1}{2}k_1x_1^2$

and work done in case of second spring is

$$W_2 = \frac{1}{2}k_2x_2^2 \text{ so } \frac{W_1}{W_2} = \frac{x_1}{x_2} \Rightarrow W_1 < W_2$$

It means that more work is done in case of second spring (work done on spring is equal to stored elastic potential energy of the spring)

7. **(a)** Here both the gun and bullet have same momentum. As the mass of the gun is larger, so the kinetic energy of the gun is less than that of bullet.

8. **(a)** Since momentum of both bodies are equal

$$\text{So } p_1 = p_2 \Rightarrow \frac{M_1}{M_2} = \frac{u_2}{u_1} \Rightarrow u_2 > u_1 \text{ (let } M_1 > M_2)$$

$$\text{so } \frac{E_{k_1}}{E_{k_2}} = \frac{P_1^2/2M_1}{P_2^2/2M_2} = \frac{M_2}{M_1} \Rightarrow E_{k_1} < E_{k_2}$$

It means that light body has greater kinetic energy, if they have equal momentum.

9. **(b)** The work is done against gravity so it is equal to the change in potential energy. $W = E_p = mgh$

For a fixed height, work is proportional to weight lifted. Since Johnny weighs twice as much as Jane he works twice as hard to get up the hill.

Power is work done per unit time. For Johnny this is $W/\Delta t$. Jane did half the work in half the time, $(1/2\ W)/(1/2\ \Delta t) = W/Dt$ which is the same power delivered by Johnny.

10. **(a)**

11. **(b)** According to law of conservation of energy total energy remains conserved.

P.E. $= mgh = 20\,mg$

Loss in potential energy is observed, as

$(P.E.)^1 = mgh = 5mg$

$(P.E)^1/(P.E) = 5mg/20mg = 1/4$

$(P.E.)^1 = 1/4$ P.E

12. **(a)**

13. **(d)** Mechanical energy is the ability of an object to do work. This energy is equal to the sum of kinetic and potential energy, it is always constant.

14. **(d)** Work done is given by, $w = F\ s \cos\theta$

where θ is the angle between the directions of force applied and displacement.

In cases 1 and 3,

$\therefore$ work done $= 0$

In case 2, $w = f\ s \cos 0 = mgh$, h being height covered.

In case 4, force is always perpendicular to motion

i.e., $\theta = 90°$, hence $w = 0$

15. **(d)** Because they have equal momenta, hence equal *mv*, the heavy body will move very slowly and the light body will move very quickly. As Kinetic energy is $\frac{1}{2}mv^2$. Thus the speed of the light body will be high giving a higher kinetic energy to it in comparison to the kinetic energy of heavy body.

16. **(b)** The relation between linear momentum (P) and kinetic energy (K) is $K = \frac{P^2}{2m}$

$$K_A = \frac{P_A^2}{2m} \text{ and } K_B = \frac{P_B^2}{2(4m)}$$

$$\frac{K_A}{K_B} = \frac{P_A^2}{2m} \times \frac{8m}{P_B^2} \qquad [P_A = P_B, \text{ given}]$$

$$\frac{K_A}{K_B} = \frac{4}{1} = 4:1$$

17. **(b)** Using, $KE = \frac{P^2}{2m}$

$$\frac{P_A^2}{2m_A} = \frac{P_B^2}{2m_B} \qquad [KE_A = KE_B \text{ given }]$$

$P_A < P_B$ [as, $m_A > m_B$]

Now from Newton's second law

$$F_{ext} = \frac{\Delta P}{\Delta t} \Rightarrow \Delta P = F_{ext}\,\Delta t$$

$\Rightarrow \quad \Delta P_A < \Delta P_B \Rightarrow F_{ext}\,\Delta t_A < F_{ext}\,\Delta t_B$

$\Rightarrow \Delta t_A < \Delta t_B$ [equal braking force is hence on comparing time Δt_A and Δt_B]

we can say that car B will cover a greater distance.

18. **(b)** We know that

Potential energy = mgh

Hence potential energy is maximum at the maximum height.

19. **(b)**

20. **(c)**

5

SS

i i

-1

1. The centre of mass of a rigid body lies
(a) inside the body (b) outside the body
(c) neither (a) nor (b) (d) either (a) or (b)

2. The motion of the centre of mass depends on
(a) total external forces (b) total internal forces
(c) sum of (a) and (b) (d) None of these

3. The sum of moments of all the particles in a system about the centre of mass is always
(a) maximum (b) minimum
(c) infinite (d) zero

4. The centre of mass of two particles lies on the line
(a) joining the particles
(b) perpendicular to the line joining the particles
(c) at any angle to this line
(d) None of these

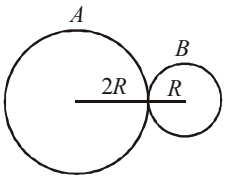
5. A system consists of three particles, each of mass m and located at (1, 1), (2, 2) and (3, 3). The co-ordinates of the centre of mass are
(a) (1, 1) (b) (2, 2)
(c) (3, 3) (d) (6, 6)

6. A cylinder of water, is rotating about its own axis with uniform angular velocity ω. The shape of free surface of water will be
(a) parabola (b) elliptical
(c) circular (d) spherical

7. If the resultant of all external forces is zero, then velocity of centre of mass will be
(a) zero (b) constant
(c) either (a) or (b) (d) neither (a) nor (b)

8. A stick is thrown in the air and lands on the ground at some distance from the thrower. The centre of mass of the stick will move along a parabolic path
(a) in all cases
(b) only if the stick is uniform
(c) only if the stick has linear motion but no rotational motion
(d) only if the stick has a shape such that its centre of mass is located at some point on it and not outside it

9. Two spheres *A* and *B* of masses *m* and 2*m* and radii 2*R* and *R* respectively are placed in contact as shown. The COM of the system lies



(a) inside *A* (b) inside *B*
(c) at the point of contact (d) None of these

10. A ball tied to a string is swung in a vertical circle. Which of the following remains constant?
(a) tension in the string (b) speed of the ball
(c) centripetal force (d) earth's pull on the ball

11. Statement 1 : When you lean behind over the hind legs of the chair, the chair falls back after a certain angle.
Statement 2 : Centre of mass lying outside the system makes the system unstable.
(a) Statement -1 is false, Statement-2 is true
(b) Statement -1 is true, Statement-2 is true; Statement -2 is a correct explanation for Statement-1
(c) Statement -1 is true, Statement-2 is true; Statement -2 is not a correct explanation for Statement-1
(d) Statement -1 is true, Statement-2 is false

12. Centre of mass of the earth and the moon system lies
(a) closer to the earth
(b) closer to the moon
(c) at the mid-point of line joining the earth and the moon
(d) cannot be predicted

13. A shell following a parabolic path explodes somewhere in its flight. The centre of mass of fragments will continue to move in
(a) vertical direction (b) any direction
(c) horizontal direction (d) same parabolic path

14. Two particles of mass m_1 and m_2 ($m_1 > m_2$) attract each other with a force inversely proportional to the square of the distance between them. If the particles are initially held at rest and then released, the centre of mass will
(a) move towards m_1 (b) move towards m_2
(c) remains at rest (d) None of these

15. In which case application of angular velocity is useful?
(a) when a body is rotating
(b) when a velocity of body is in a straight line
(c) when acceleration of body is in a straight line
(d) none of these

16. A man standing on a rotating table is holding two masses at arm's length. Without moving his arms, he drops the two masses. His angular speed will
(a) increase (b) decrease
(d) become zero (d) remain constant

17. In rotatory motion, linear velocities of all the particles of the body are
(a) same (b) different
(c) zero (d) cannot say

18. Rotational analogue of force in linear motion is
(a) weight (b) angular momentum
(c) moment of inertia (d) torque

19. A boy comes and sits suddenly on a circular rotating table. What will remain conserved for the table-boy system?
(a) Angular velocity (b) Angular momentum
(c) Linear momentum (d) Angular acceleration

20. According to the principle of conservation of angular momentum, if moment of inertia of a rotating body decreases, then its angular velocity
(a) decreases (b) increases
(c) remains constant (d) becomes zero

21. Which of the following statements about angular momentum is correct?
(a) It is directly proportional to moment of inertia
(b) It is a scalar quantity
(c) both (a) and (b)
(d) None of these

22. A disc is given a linear velocity on a rough horizontal surface then its angular momentum is
(a) conserved about COM only
(b) conserved about the point of contact only
(c) conserved about all the points
(d) not conserved about any point.

23. A body is projected from ground with some angle to the horizontal. The angular momentum about the initial position will
(a) decrease
(b) increase
(c) remains same
(d) first increase then decrease

24. A gymnast takes turns with her arms & legs stretched. When she pulls her arms & legs in
(a) the angular velocity decreases
(b) the moment of inertia decreases
(c) the angular velocity stays constant
(d) the angular momentum increases

25. Angular momentum is
(a) a polar vector (b) an axial vector
(c) a scalar (d) None of these

26. If a running boy jumps on a rotating table, which of the following is conserved?
(a) Linear momentum
(b) Kinetic energy
(c) Angular momentum
(d) None of these

27. A solid sphere is rotating in free space. If the radius of the sphere is increased keeping mass same which one of the following will not be affected ?
(a) Angular velocity
(b) Angular momentum
(c) Moment of inertia
(d) Rotational kinetic energy

28. Angular momentum is
(a) moment of momentum
(b) product of mass and angular velocity
(c) product of M.I. and velocity
(d) moment of angular motion

29. The angular momentum of a system of particle is conserved
(a) when no external force acts upon the system
(b) when no external torque acts upon the system
(c) when no external impulse acts upon the system
(d) when axis of rotation remains same

30. A couple is acting on a two particle systems. The resultant motion will be
(a) purely rotational motion
(b) purely linear motion
(c) both a and b
(d) None of these

31. Angular momentum of a system a particles changes, when
(a) force acts on a body
(b) torque acts on a body
(c) direction of velocity changes
(d) None of these

32. Analogue of mass in rotational motion is
(a) moment of inertia (b) angular momentum
(c) gyration (d) None of these

33. Moment of inertia does not depend upon
(a) angular velocity of body
(b) shape and size
(c) mass
(d) position of axis of rotation

34. During summersault, a swimmer bends his body to
(a) increase moment of Inertia
(b) decrease moment of Inertia
(c) decrease the angular momentum
(d) reduce the angular velocity

35. Of the two eggs which have identical sizes, shapes and weights, one is raw, and other is half boiled. The ratio between the moment of inertia of the raw to the half boiled egg about central axis is
(a) one (b) greater than one
(c) less than one (d) not comparable

36. A mass is resolving in a circle which is in the plane of paper. The direction of angular acceleration is
(a) upward the radius
(b) towards the radius
(c) tangential
(d) at right angle to angular velocity

37. A ring of mass m and radius r is melted and then moulded into a sphere. The moment of inertia of the sphere will be
(a) more than that of the ring
(b) less than than of the ring
(c) equal to that of the ring
(d) None of these

38. One solid sphere and disc of same radius are falling along an inclined plane without slipping. One reaches earlier than the other due to
(a) different radius of gyration
(b) different sizes
(c) different friction
(d) different moment of inertia

39. A solid sphere, disc and solid cylinder all of the same mass and made of the same material are allowed to roll down (from rest) on an inclined plane, then
(a) solid sphere reaches the bottom first
(b) solid sphere reaches the bottom last
(c) disc will reach the bottom first
(d) all reach the bottom at the same time

40. When a mass is rotating in a plane about a fixed point, its angular momentum is directed along the
(a) radius of orbit
(b) tangent to the orbit
(c) line parallel to plane of rotation
(d) line perpendicular to plane of rotation

41. A body cannot roll without slipping on a
(a) rough horizontal surface
(b) smooth horizontal surface
(c) rough inclined surface
(d) smooth inclined surface

42. When a body starts to roll on an inclined plane, its potential energy is converted into
(a) translation kinetic energy only
(b) translation and rotational kinetic energy
(c) rotational energy only
(d) None of these

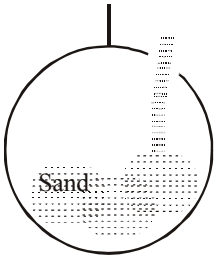
43. A body rolls down an inclined plane. If its K.E. of rotational motion is 40% of its K.E. of translational, then the body is a
(a) cylinder (b) ring
(c) solid disc (d) solid sphere

44. Relation between torque and angular momentum is similar to the relation between
(a) energy and displacement
(b) acceleration and velocity
(c) mass and moment of inertia
(d) force and linear momentum

45. For which one of the following does the centre of mass lie outside the body?
(a) A fountain pen (b) A cricket ball
(c) A ring (d) A book

-

1. A hollow sphere is held suspended. Sand is now poured into it in stages.



The centre of gravity of the sphere with the sand
(a) rises continuously
(b) remains unchanged in the process
(c) First rises and then falls to the original position
(d) First falls and then rises to the original position

2. A man stands at one end of a boat which is stationary in water. Neglect water resistance. The man now moves to the other end of the boat and again becomes stationary. The centre of mass of the 'man plus boat' system will remain stationary with respect to water
(a) in all cases
(b) only when the man is stationary initially and finally
(c) only if the man moves without acceleration on the boat
(d) only if the man and the boat have equal masses

3. A composite disc is to be made using equal masses of aluminium and iron so that it has as high a moment of inertia as possible. This is possible when
(a) the surfaces of the disc are made of iron with aluminium inside
(b) the whole of aluminium is kept in the core and the iron at the outer rim of the disc
(c) the whole of the iron is kept in the core and the aluminium at the outer rim of the disc
(d) the whole disc is made with thin alternate sheets of iron and aluminium

4. A solid cylinder and a hollow cylinder both of the same mass and same external diameter are released from the same height at the same time on an inclined plane. Both roll down without slipping. Which one will reach the bottom first?
(a) Solid cylinder
(b) Both together
(c) One with higher density
(d) Hollow cylinder

5. Let I_1 and I_2 be the moments of inertia of two bodies of identical geometrical shape, the first made of aluminium and the second of iron. Then
(a) $I_1 > I_2$
(b) $I_1 = I_2$
(c) $I_1 < I_2$
(d) relation between I_1 and I_2 depends on the actual shapes of the bodies

6. A particle is confined to rotate in a circular path decreasing linear speed, then which of the following is correct?
(a) $\vec{L}$ (angular momentum) is conserved about the centre
(b) only direction of angular momentum $\vec{L}$ is conserved
(c) It spirals towards the centre
(d) its acceleration is towards the centre.

7. Two particles A and B, initially at rest, moves towards each other under a mutual force of attraction. At the instant when the speed of A is v and the speed of B is 2 v, the speed of centre of mass is
(a) zero (b) v
(c) 1.5 v (d) 3 v

8. A ball balanced on a vertical rod is an example of
(a) stable equilibrium (b) unstable equilibrium
(c) neutral equilibrium (d) perfect equilibrium

9. Three identical particles each of mass 1 kg are placed touching one another with their centres on a straight line. Their centres are marked A, B and C respectively. The distance of centre of mass of the system from A is
(a) $\frac{AB + AC + BC}{3}$ (b) $\frac{AB + AC}{3}$
(c) $\frac{AB + BC}{3}$ (d) $\frac{AC + BC}{3}$

10. There are some passengers inside a stationary railway compartment. The centre of mass of the compartment itself (without the passengers) is C_1, while the centre of mass of the 'compartment plus passengers' system is C_2. If the passengers move about inside the compartment then
(a) both C_1 and C_2 will move with respect to the ground
(b) neither C_1 nor C_2 will be stationary with respect to the ground
(c) C_1 will move but C_2 will be stationary with respect to the ground
(d) C_2 will move but C_1 will be stationary with respect to the ground

11. A man hangs from a rope attached to a hot-air balloon. The mass of the man is greater than the mass of the balloon and its contents. The system is stationary in air. If the man now climbs up to the balloon using the rope, the centre of mass of the 'man plus balloon system will
(a) remain stationary
(b) move up
(c) move down
(d) first move up and then return to its initial position

12. In a bicycle, the radius of rear wheel is twice the radius of front wheel. If r_F and r_F are the radii, v_r and v_r are the speed of top most points of wheel. Then
(a) $v_r = 2v_F$ (b) $v_F = 2v_r$
(c) $v_F = v_r$ (d) $v_F > v_r$

13. A mass m is moving with a constant velocity along a line parallel to the x-axis, away from the origin. Its angular momentum with respect to the origin
(a) is zero (b) remains constant
(c) goes on increasing (d) goes on decreasing.

14. A smooth sphere A is moving on a frictionless horizontal plane with angular speed ω and centre of mass velocity v. It collides elastically and head on with an identical sphere B at rest. Neglect friction everywhere. After the collision, their angular speeds are ω_A and ω_B, respectively. Then
(a) $\omega_A < \omega_B$ (b) $\omega_A = \omega_B$
(c) $\omega_A = \omega$ (d) $\omega_B = \omega$

15. A raw egg and a hard boiled egg are made to spin on a table with the same angular momentum about the same axis. The ratio of the time taken by the two to stop is
(a) = 1 (b) < 1
(c) > 1 (d) None of these

HINTS & EXPLANATIONS

Level-1

1. (d) The centre of mass of a body may lie anywhere (inside/outside) of the body.

2. (a) The motion of centre of mass depends only on external forces.

3. (d) The sum of moments of masses of all the particles in a system about the centre of mass is always zero.

4. (a) The centre of mass of two particles lies always on the line joining the two particles.

5. (b) The coordinates of C.M of three particle are

$$x = \frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3} \text{ \& } y = \frac{m_1y_1 + m_2y_2 + m_3y_3}{m_1 + m_2 + m_3}$$

here $m_1 = m_2 = m_3 = m$

$$\text{so } x = \frac{(x_1 + x_2 + x_3)m}{m + m + m} = 2,\ y = \frac{(y_1 + y_2 + y_3)m}{m + m + m} = 2$$

so coordinates of C.M. of three particle are (2,2)

6. (a) The shape of free surface of water is parabolic, because of difference in centrifugal force ($F = mr\omega^2$, which is proportional to r)

7. (c)

8. (a) We may consider the entire mass of the stick to be concentrated as a point mass at the centre of mass of the stick. The centre of mass moves as a projectile, it will move along a parabolic path.

9. (c)

10. (d) The pull of earth changes only when the body moves so that g changes. It is an exceptional case and should not be considered unless otherwise mentioned.

11. (d) **12. (a)**

13. (d) The centre of mass of fragments will continue to move in same parabolic path, as explosion is due to internal forces only.

14. (c) The centre of mass remains at rest because force of attraction is mutual. No external force is acting.

15. (a)

16. (a) As mass decreases, moment of inertia I decreases. Since $L = I\omega$ is constant, therefore ω increases.

17. (b) From $v = r\omega$, linear velocities (v) for particles at different distances (r) from the axis of rotation are different.

18. (d) Force in linear motion corresponds to torque in rotational motion.

19. (b) Angular momentum will remain conserved as no torque is exerted by the boy.

20. (b) As $L = I\omega$ = constant, therefore, when I decreases, ω will increase.

21. (a) From $L = I\omega$, we find that angular momentum is directly proportional to the moment of inertia.

22. (b) **23. (b)**

24. (b) Since no external torque act on gymnast, so angular momentum ($L = I\omega$) is conserved. After pulling her arms & legs, the angular velocity increases but moment of inertia of gymnast, decreases in, such a way that angular momentum remains constant.

25. (b) Angular momentum $\vec{L}$ is defined as $\vec{L} = \vec{r} \times m(\vec{v})$

so $\vec{L}$ is, an axial vector.

26. (c) The boy does not exert a torque to rotating table by jumping, so angular momentum is conserved i.e.,

$$\frac{d\vec{L}}{dt} = 0 \Rightarrow \vec{L} = \text{constant}$$

27. (b) Angular momentum will remain the same since external torque is zero.

28. (a) Angular momentum $= \vec{r} \times (\text{linear momentum})$

29. (b) We know that $\tau_{ext} = \frac{dL}{dt}$

if angular momentum is conserved, it means change in angular momentum = 0

or, dL = 0

$$\frac{dL}{dt} = 0 \Rightarrow \tau_{ext} = 0$$

Thus total external torque = 0.

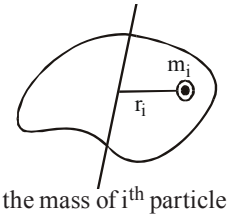
30. (a) A couple consists of two equal and opposite forces whose lines of action are parallel and laterally separated by same distance. Therefore, net force (or resultant) of a couple is null vector, hence no translatory motion will be produced and only rotational motion will be produced.

31. (b) If we apply a torque on a body, then angular momentum of the body changes according to the relation

$$\vec{\tau} = \frac{d\vec{L}}{dt} \Rightarrow \text{if } \vec{\tau} = 0 \text{ then, } \vec{L} = \text{constant}$$

32. (a) Analogue of mass in rotational motion is moment of inertia. It plays the same role as mass plays in translational motion.

33. (a) Basic equation of moment of inertia is given by $I = \sum_{i=1}^{n} m_i r_i^2$



where m_i is the mass of i^{th} particle at a distance of r_i from axis of rotation.

Thus it does not depend on angular velocity.

34. **(b)** By bending his body, he decreases his moment of inertia. This would increase his angular velocity.

35. **(b)** A raw egg behaves like a spherical shell and a half boiled egg behaves like a solid sphere

$$\therefore \quad \frac{I_r}{I_s} = \frac{2/3\ mr^2}{2/5\ mr^2} = \frac{5}{3} > 1$$

36. **(a)** **37.** **(b)**

38. **(a)** (i) For solid sphere, the moment of inertia about the diameter is $I_s = \frac{2}{5}MR^2$

Now $I = MK^2$ for any body, where K is radius of gyration of that body.

so $MK^2 = \frac{2}{5}MR^2 \Rightarrow K = R\sqrt{2/5}$ ...(i)

(ii) The moment of inertia of disc about an axis passing through its centre & perpendicular to plane is

$$I_d = \frac{MR^2}{2} = MK^2 \Rightarrow K = R\sqrt{½} \quad ...(ii)$$

Now acceleration of any body which is rolling on an inclined plane is

$$a = \frac{g\sin\theta}{1+K^2/R^2} \quad ...(iii)$$

For same R, the acceleration of the body depends only on radius of gyration K, [see eq(iii)] so solid sphere will reach earlier to bottom of an inclined plane than disc.

39. **(a)** For solid sphere $\frac{K^2}{R^2} = \frac{2}{5}$

For disc & solid cylinder $\frac{K^2}{R^2} = \frac{1}{2}$

Since acceleration of a body, which is rolling on an inclined plane at angle θ with horizontal is

$$a = \frac{g\sin\theta}{1+K^2/R^2} \quad .....(i)$$

It is clear from eq. (i) that

$a_{\text{solid sphere}} > a_{\text{disc}} = a_{\text{solid cylinder}}$

hence solid sphere take least time in reaching the bottom of the inclined plane.

40. **(d)** As angular momentum, $\vec{L} = \vec{r} \times \vec{p}$, therefore, direction of $\vec{L}$ is along a line perpendicular to the plane of rotation.

41. **(d)**

42. **(b)** P.E. of the body is converted into both translational KE and rotational K.E i.e., $P.E = \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2$

43. **(d)** $\frac{\text{K.E. of rotation}}{\text{K.E. of translation}} = \frac{40}{100} = \frac{2}{5}$

i.e. $\frac{\frac{1}{2}I\omega^2}{\frac{1}{2}mv^2} = \frac{1/2I\omega^2}{1/2mr^2\omega^2} = \frac{2}{5}$ or $I = \frac{2}{5}mr^2$

Hence the body is a solid sphere.

44. **(d)** $\tau = dL/dt$ corresponds to $F = dp/dt$ i.e. relation between force and momentum.

45. **(c)** The centre of mass of a body is the point where the whole mass of a body is considered to be concentrated. It may lie within or outside the body of an object. Fountain pen, cricket ball and book are all compact body and their centre of gravity lie within the body. The centre of mass of a ring is at its centre which is outside its body.

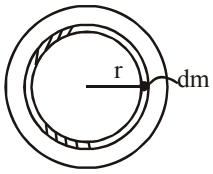
Level-2

1. **(d)** Initially centre of gravity is at the centre. When sand is poured it will fall and again after a limit, centre of gravity will rise.

2. **(a)** There are no external horizontal forces acting on the 'man plus boat' system. (The forces exerted by the man and the boat on each other are internal forces for the system.) Therefore, the centre of mass of the system, which is initially at rest, will always be at rest.

3. **(b)** Density of iron > density of aluminium

moment of inertia $= \int r^2 dm$.



$\therefore$ Since $\rho_{\text{iron}} > \rho_{\text{aluminium}}$

so whole of aluminium is kept in the core and the iron at the outer rim of the disc.

4. **(a)** Solid cylinder reaches the bottom first because for solid cylinder $\frac{K^2}{R^2} = \frac{1}{2}$ and for hollow cylinder, $\frac{K^2}{R^2} = 1$.

Acceleration down the inclined plane $\propto \frac{1}{1+K^2/R^2}$.

Solid cylinder has greater acceleration. It reaches the bottom first.

5. **(c)** In this case radius of gyration of both bodies are same but iron has greater density in comparison to aluminium.

So $I_2 = M_{\text{iron}} \times K^2$

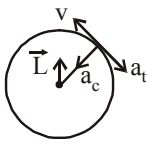
$I_1 = M_{\text{alu}} \times K^2$

Where K is radius of gyration

$M_{\text{iron}} = \rho_{\text{iron}} \times \text{volume}$, $M_{\text{alu}} = \rho_{\text{alu}} \times \text{volume}$

$$\Rightarrow \frac{I_2}{I_1} = \frac{M_{\text{iron}}}{M_{\text{alu}}} = \frac{\rho_{\text{iron}}}{\rho_{\text{alu}}} \Rightarrow I_2 > I_1$$

6. **(b)** Since v is changing (decreasing), L is not conserved in magnitude. Since it is given that a particle is confined to rotate in a circular path, it can not have spiral path. Since the particle has two accelerations a_c and a_t therefore the net acceleration is not towards the centre.



The direction of $\vec{L}$ remains same even when the speed decreases.

7. **(a)** Force F_A on particle A is given by

$$F_A = m_A a_A = \frac{m_A v}{t} \quad ...(1)$$

Similarly $F_B = m_B a_B = \frac{m_B \times 2v}{t}$ ...(2)

Now $\frac{m_A v}{t} = \frac{m_B \times 2v}{t}$ $(\because F_A = F_B)$

So $m_A = 2m_B$

For the centre of mass of the system

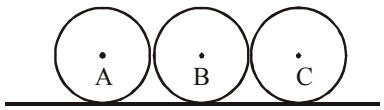
$$v = \frac{m_A v_A + m_B v_B}{m_A + m_B}$$

or $v = \frac{2m_B v - m_B \times 2v}{2m_B + m_B} = 0$

Negative sign is used because the particles are travelling in opposite directions.

8. **(b)**

9. **(b)** Position of C.M w.r. to A



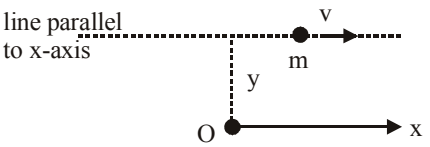
$$= \frac{1\times 0 + 1\times AB + 1\times AC}{1+1+1} = \frac{AB + AC}{3}$$

10. **(c)** Choosing the compartment as the system, the passengers are external to the compartment, and can apply horizontal forces on it. Thus, C_1 may move. For the 'compartment plus passengers' system, there are no external horizontal forces. Thus, C_2 will not move.

11. **(a)** As the system is stationary in air, the net external vertical forces on it is zero.

12. **(c)** The velocity of the top point of the wheel is twice that of centre of mass. And the speed of centre of mass is same for both the wheels.

13. **(b)** Angular momentum of mass m moving with a constant velocity about origin is



L = momentum × perpendicular distance of line of action of momentum from origin

$L = mv \times y$

In the given condition mvy is a constant. Therefore angular momentum is constant.

14. **(c)** Since the spheres are smooth, there will be no transfer of angular momentum from the sphere A to sphere B. The sphere A only transfers its linear velocity v to the sphere B and will continue to rotate with the same angular speed ω.

15. **(b)** So raw egg is like a spherical shell & hard bioled egg is like solid sphere. Let I_1, I_2 be M. I. of raw egg and boiled egg respectively.

Given that angular momentum L, is same

$\therefore I_1\omega_1 = I_2\omega_2 \Rightarrow \omega_2 > \omega_1 \because I_1 > I_2$

Now from first equation of angular motion ($\omega_f = \omega_i + \alpha t$) here α is retarding decceleration for both cases & $\omega_f = 0$ for both case.

So $\frac{t_1(\text{raw egg})}{t_2(\text{hard egg})} = \frac{\omega_1/\alpha}{\omega_2/\alpha} \Rightarrow \frac{t_1}{t_2} < 1$

6 c iy

-1

1. The force of gravitation between two bodies does not depend on:
(a) their separation
(b) the product of their masses
(c) the sum of their masses
(d) the gravitational constant

2. The acceleration due to gravity
(a) has the same values everywhere in space
(b) has the same value everywhere on the earth
(c) varies with the latitude on the earth
(d) is greater on the moon due to its smaller diameter

3. Newton's law of gravitation is applicable to
(a) bodies of the solar system only
(b) bodies on the earth
(c) planets only
(d) all bodies of the universe

4. The force that causes acceleration and keeps the body moving along the circular path is acting
(a) towards the center
(b) away from the center
(c) along the tangent to the circular path
(d) in the direction of circular motion

5. All bodies whether large or small fall with the
(a) same force (b) same acceleration
(c) same velocity (d) same momentum

6. Weightlessness experienced while orbiting the earth in a spaceship is the result of
(a) zero gravity (b) inertia
(c) acceleration (d) centre of gravity

7. When an object falls freely to the earth, the force of the gravity is
(a) opposite to the direction of motion
(b) in the same direction as that of motion
(c) zero
(d) constant

8. The weight of a body at the centre of the earth is
(a) zero
(b) infinite
(c) same as at other places
(d) slightly greater than that at poles

9. The weight of an object
(a) is the gravity of the matter it contains
(b) refers to its inertia
(c) is the same as its mass but expressed in different units
(d) is the force with which it is attracted to the earth

10. At which of the following locations, the value of g is the largest?
(a) On top of the Mount Everest
(b) On top of Qutub Minar
(c) At a place on the equator
(d) A camp site in Antarctica

11. A ball is thrown vertically upwards. The acceleration due to gravity.
(a) is in the direction opposite to the direction of its motion
(b) is in the same direction as the direction of its motion
(c) increases as it comes down
(d) becomes zero at the highest point

12. Universal law of gravitation states that every object in the universe
(a) Attracts every other object with a force
(b) The force of attraction is proportional to the product of their masses
(c) The force is inversely proportional to the square of the distance between them
(d) All of these

13. Kepler's laws governing the motion of planets are:
(a) The orbit of a planet is an eclipse with the Sun at one of the foci
(b) The line joining the planet and the Sun sweep equal areas in equal intervals of time
(c) The cube of the mean distance of a planet (r) from the Sun is proportional to the square of its orbital period (T)
(d) All of these

14. According to Kepler, force acting on an orbiting planet is given by
(a) $F = m g$ (b) $F O < v^2 / r$
(c) $F = m g h$ (d) None of these

15. Pick up the correct relationship
(a) Gravitational constant $G = Fd^2 / M \times m$
(b) $G = g M / R^2$
(c) $G = g$ (d) All of these

16. The gravitational force between two objects is F. If masses of both objects are halved without changing distance between them, then the gravitational force would become
(a) F/4 (b) F/2
(c) F (d) 2 F

17. S.I. Unit of G is
(a) $m s^{-2}$ (b) $N m^2 kg^{-2}$
(c) No unit (d) None of these

18. Two particles are placed at some distance. If the mass of each of the two particles is doubled, keeping the distance between them unchanged, the value of gravitational force between them will be

(a) $\frac{1}{4}$ times (b) 4 times

(c) $\frac{1}{2}$ times (d) unchanged

19. The weight of an object at the centre of the earth of radius R is

(a) zero
(b) infinite
(c) R times the weight at the surface of the earth
(d) $1/R^2$ times the weight at surface of the earth

20. Value of G is

(a) $9.8\ m\ s^{-2}$
(b) $6.673 \times 10^{-11}\ N\ m^2\ kg^{-2}$
(c) 6.673 N
(d) 9.8 N

21. An apple falls from a tree because of gravitational attraction between the earth and apple. If F_1 is the magnitude of force exerted by the earth on the apple and F_2 is the magnitude of force exerted by apple on earth, then

(a) F_1 is very much greater than F_2
(b) F_2 is very much greater than F_1
(c) F_1 is only a little greater than F_2
(d) F_1 and F_2 are equal

22. Gravitational force between the earth and an object on the surface of earth is best given by the formula

(a) $F = m\ g$ (b) $F = g\ M / r^2$
(c) $F = G \times M \times m / d^2$ (d) All of these

23. Four planets A, B, C and D made up of same material have radius of $\frac{r}{2}$, r, $2r$ and $4r$ respectively. The order of the planets in increasing order of the acceleration due to gravity (on their surface) is

(a) A, B, C, D (b) B, C, D, A
(c) A, C, B, D (d) D, C, B, A

24. Universal law of gravitation explains the phenomenon

(a) The force that binds us to the earth
(b) The motion of the moon around the earth or planets around the Sun
(c) The tides due to the moon and the Sun
(d) All of the these

25. Acceleration due to gravity for objects on or near the surface of the earth is represented as

(a) $g = G\ M / R^2$ (b) $g = G\ M\ m / d^2$
(c) Both (a) and (b) (d) Neither (a) nor (b)

26. Kepler's second law regarding constancy of areal velocity of a planet is a consequence of the law of conservation of

(a) energy (b) angular momentum
(c) linear momentum (d) None of these

27. If the the earth is at one-fourth of its present distance from the sun, the duration of year will be

(a) half the present year
(b) one-eight the present year
(c) one-fourth the present year
(d) one-sixth the present year

28. Newton's universal law of gravitation applies to

(a) small bodies only
(b) planets only
(c) both small and big bodies
(d) only valid for solar system

29. Two identical spheres of gold are in contact with each other. The gravitational attraction between them is

(a) directly proportional to the square of the radius
(b) directly proportional to the cube of the radius
(c) directly proportional to the fourth power of the radius
(d) inversely proportional to the square of the radius

30. Two masses m_1 and m_2 ($m_1 < m_2$) are released from rest from a finite distance. They start under their mutual gravitational attraction –

(a) acceleration of m_1 is more than that of m_2.
(b) acceleration of m_2 is more than that of m_1.
(c) centre of mass of system will remain at rest in all the reference frame
(d) total energy of system remains constant

31. The gravitational force Fg btween two objects does not depend on

(a) Sun of masses
(b) product of masses
(c) distance between masses
(d) Gravitational constant

32. The atmosphere is held tothe earth by

(a) winds (b) clouds
(c) Gravity (d) None of these

33. Two air bubbles in water

(a) attract each other
(b) repel each other
(c) neither attract nor repel
(d) None of these

34. The tides in sea are primarily due to the

(a) atmospheric effect of the earth
(b) gravitational effect of venus on the earth
(c) gravitational effect of the sun on the earth
(d) gravitational effect of the moon on the earth

35. The gravitational force btween two point masses m_1 and M_2 at separation r is given by $F = k\frac{m_1 m_2}{r^2}$. The constant k

(a) depends on system of units only
(b) depends on medium btweeen masses
(c) depends on both (a) and (b)
(d) is independent of both (a) and (b)

36. The weight of a body at the centre of the earth is

(a) zero
(b) infinite
(c) same as on the surface on earth
(d) none of these

37. As we go from the equator to the poles, the value of g
(a) remains the same
(b) decreases
(c) increases
(d) decreases upto latitude of 45°

38. A man waves his arms while walking. This is to
(a) keep constant velocity
(b) ease the tension
(c) increase the velocity
(d) balance the effect of earth's gravity

39. At sea level, a body will have minimum weight at
(a) pole (b) equator
(c) 42° south latitude (d) 37° north latitude

40. If the earth losses its Gravity, then for a body
(a) weight becomes zero, but not the mass
(b) mass becomes zero, but not the weight
(c) both mass and weight become zero
(d) neither mass nor weight become zero

41. A small satellite is revolving near earth's surface. It's orbital velocity will be nearly
(a) 8 km/sec (b) 11.2 km/sec
(c) 10 km/sec (d) 6 km/sec

42. The escape velocity of an object projected from the surface of a given planet is independent of
(a) radius of the planet
(b) the direction of projection
(c) the mass of the planet
(d) None of these

43. The period of a satellite in a circular orbit near a planet is independent of
(a) the mass of the planet
(b) the radius of the planet
(c) the mass of the satellite
(d) All of the above

44. In planetary motion
(a) the angular speed remains constant
(b) the total angular momentum remains constant
(c) the linear speed remains constant
(d) neither the angular momentum nor angular speed remains constant

45. To an astronaut in a spaceship the sky appears black due to
(a) absence of atmosphere in his neighbourhood
(b) light from the sky is absorbed by the medium surrounding him
(c) the fact at that height, sky radiations are only in the infra-red and the ultraviolet region
(d) None of these

46. Weightlessness experienced while orbiting the earth in spaceship is the result of
(a) inertia (b) acceleration
(c) zero gravity (d) centre of gravity

47. A satellite is orbiting around the earth near its surface. If its kinetic energy is doubled, then
(a) it will remain in the same orbit.
(b) it will fall on the earth.
(c) it will revolve with greater speed.
(d) it will escape out of the gravitational field of the earth.

48. A missile is launched with a velocity less than escape velocity. The sum of its kinetic and potential energies is
(a) zero
(b) negative
(c) positive
(d) may be positive, negative or zero.

49. Due to rotation of the earth the acceleration due to gravity g is
(a) maximum at the equator and minimum at the poles
(b) minimum at the equator and maximum at the poles
(c) same at both places
(d) None of these

50. There is no atmosphere on the moon because
(a) it is closer to the earth
(b) it revolves round the earth
(c) it gets light from the sun
(d) the escape velocity of gas molecules is lesser than their root mean square velocity

51. The force of gravitation between two bodies does not depend on:
(a) their separation
(b) the product of their masses
(c) the sum of their masses
(d) the gravitational constant

52. The acceleration due to gravity
(a) has the same values everywhere in space
(b) has the same value everywhere on the earth
(c) varies with the latitude on the earth
(d) is greater on the moon due to its smaller diameter

53. Newton's law of gravitation is applicable to
(a) bodies of the solar system only
(b) bodies on the earth
(c) planets only
(d) all bodies of the universe

54. The force that causes acceleration and keeps the body moving along the circular path is acting
(a) towards the center
(b) away from the center
(c) along the tangent to the circular path
(d) in the direction of circular motion

55. All bodies whether large or small fall with the
(a) same force (b) same acceleration
(c) same velocity (d) same momentum

56. Weightlessness experienced while orbiting the earth in a spaceship is the result of
(a) zero gravity (b) inertia
(c) acceleration (d) centre of gravity

57. When an object falls freely to the earth, the force of the gravity is
(a) opposite to the direction of motion
(b) in the same direction as that of motion
(c) zero
(d) constant

58. The motion of the moon around the earth is due to
(a) the centrifugal force (b) the centripetal force
(c) Neither (a) nor (b) (d) Both (a) and (b)

59. The weight of a body at the centre of the earth is
(a) zero
(b) infinite
(c) same as at other places
(d) slightly greater than that at poles

60. The weight of an object
(a) is the gravity of the matter it contains
(b) refers to its inertia
(c) is the same as its mass but expressed in different units
(d) is the force with which it is attracted to the earth

61. In vacuum all freely falling objects
(a) have the same speed
(b) have the same velocity
(c) have the same acceleration
(d) have the same force

62. The centripetal force is provided to the planet by the
(a) force of repulsion between the planet and the Sun
(b) force of attraction of the Sun
(c) heat energy of the Sun
(d) All of these

63. At which of the following locations, the value of g is the largest?
(a) On top of the Mount Everest
(b) On top of Qutub Minar
(c) At a place on the equator
(d) A camp site in Antarctica

64. A ball is thrown vertically upwards. The acceleration due to gravity.
(a) is in the direction opposite to the direction of its motion
(b) is in the same direction as the direction of its motion
(c) increases as it comes down
(d) becomes zero at the highest point

65. Pressure exerted by a sharp needle on a surface is :
(a) more than the pressure exerted by a blunt needle
(b) less than the pressure exerted by a blunt needle
(c) equal to the pressure exerted by a blunt needle
(d) None of these

66. Which of the following is the force of attraction exists between objects ?
(a) The inter molecular force of attraction
(b) The force of buoyancy
(c) The friction between planet and Sun
(d) The force of attraction between objects is called the gravitational force.

67. Buoyant force on an object due to a fluid always acts:
(a) in the downward direction
(b) side ways
(c) in the upper direction
(d) None of these

68. Universal law of gravitation states that every object in the universe
(a) Attracts every other object with a force
(b) The force of attraction is proportional to the product of their masses
(c) The force is inversely proportional to the square of the distance between them
(d) All of these

69. Iron nail sinks in water because :
(a) weight of nail is less than the buoyant force acting on it due to water
(b) weight of nail is equal to the buoyant force acting on it due to water
(c) weight of nail is greater than the buoyant force acting on it due to water
(d) weight of nail increases in the water

70. An object just foats in water. If common salt is added into the water
(a) the volume of the object immersed in the liquid decreases
(b) the object sinks
(c) the object first sinks and then floats up
(d) cannot be determined

71. Kepler's laws governing the motion of planets are:
(a) The orbit of a planet is an eclipse with the Sun at one of the foci
(b) The line joining the planet and the Sun sweep equal areas in equal intervals of time
(c) The cube of the mean distance of a planet (r) from the Sun is proportional to the square of its orbital period (T)
(d) All of these

72. A substance floats in water, but sinks in coconut oil. The density of the substance
(a) is less than the density of water
(b) is greater than the density of oil
(c) Both (a) and (b)
(d) Cannot be decided from the given information

73. Pick up the correct relationship
(a) Gravitational constant $G = Fd^2 / M \times m$
(b) $G = g M / R^2$
(c) $G = g$
(d) All of these

74. The gravitational force between two objects is F. If masses of both objects are halved without changing distance between them, then the gravitational force would become
(a) F/4 (b) F/2 (c) F (d) 2 F

75. A boy is whirling a stone tied with a string in an horizontal circular path the string breaks, the stone
(a) will continue to move in the circular path
(b) will move along a straight line towards the centre of the circular path
(c) will move along a straight line tangential to the circular path
(d) will move along a straight line perpendicular to the circular path away from the boy

76. S.I. Unit of G is
(a) $m\ s^{-2}$ (b) $N\ m^2\ kg^{-2}$
(c) No unit (d) None of these

77. Two particles are placed at some distance. If the mass of each of the two particles is doubled, keeping the distance between them unchanged, the value of gravitational force between them will be
(a) $\frac{1}{4}$ times (b) 4 times
(c) $\frac{1}{2}$ times (d) unchanged

78. The weight of an object at the centre of the earth of radius R is
(a) zero
(b) infinite
(c) R times the weight at the surface of the earth
(d) $1/R^2$ times the weight at surface of the earth

79. Value of G is
(a) $9.8\ m\ s^{-2}$ (b) $6.673 \times 10^{-11}\ N\ m^2\ kg^{-2}$
(c) 6.673 N (d) 9.8 N

80. An apple falls from a tree because of gravitational attraction between the earth and apple. If F_1 is the magnitude of force exerted by the earth on the apple and F_2 is the magnitude of force exerted by apple on earth, then
(a) F_1 is very much greater than F_2
(b) F_2 is very much greater than F_1
(c) F_1 is only a little greater than F_2
(d) F_1 and F_2 are equal

81. If upthrust U is equal to $\frac{1}{4}$ th the weight of the object in air, then the weight felt in the liquid is
(a) $\frac{1}{4}$ W (b) $\frac{3}{4}$ W
(c) $\frac{1}{2}$ W (d) 2W

82. Gravitational force between the earth and an object on the surface of earth is best given by the formula
(a) $F = m\,g$ (b) $F = g\,M / r^2$
(c) $F = G \times M \times m / d^2$ (d) All of these

83. Four planets A, B, C and D made up of same material have radius of $\frac{r}{2}$, r, $2r$ and $4r$ respectively. The order of the planets in increasing order of the acceleration due to gravity (on their surface) is
(a) A, B, C, D (b) B, C, D, A
(c) A, C, B, D (d) D, C, B, A

84. Universal law of gravitation explains the phenomenon
(a) The force that binds us to the earth
(b) The motion of the moon around the earth or planets around the Sun
(c) The tides due to the moon and the Sun
(d) All of the these

85. The least value of apparent weight of a body in a fluid is
(a) > 0
(b) $= 0$
(c) < 0
(d) depends on the density of solid and fluid

86. A heavy cylinder of length 1 is slowly taken out of a dense liquid. The weight felt as it is taken out of the liquid.
(a) will remain the same
(b) increases as it comes out
(c) decreases as it comes out
(d) increases till it attains the weight in air

87. An empty closed drum and a filled drum of same dimension will bring
(a) same upthrust (b) same volume
(c) both (a) and (b) (d) neither (a) nor (b)

88. Acceleration due to gravity for objects on or near the surface of the earth is represented as
(a) $g = G\,M / R^2$ (b) $g = G\,M\,m / d^2$
(c) Both (a) and (b) (d) Neither (a) nor (b)

89. Upthrust varies as a body comes out of the liquid as
A : It depends on immersed volume alone
B : Volume = Cross-section area × Length
Then
(a) Only A is correct
(b) Only B is correct
(c) Both A and B are correct
(d) Neither A nor B is correct

90. An earth-like planet has a radius equal to double the earth's radius. The acceleration due to gravity on its surface will be
(a) g (b) $\frac{g}{2}$ (c) $2g$ (d) g^2

91. The value of g becomes
(a) greater at the poles than at the equator
(b) greater at the equator than at the North Pole
(c) greater at the equator than at the South Pole
(d) zero at the equator

92. Four students A, B, C and D find the acceleration due to gravity at the top of Ooty, Nainital, Mount Everest and Shimla. The acceleration due to gravity is the least
(a) at Ooty since it is the highest
(b) at Mount Everest as it is the highest
(c) at Nainital as only latitude has the effect and not height of the peak.
(d) at Shimla as it is the coldest

93. Value of g is taken as
(a) Positive for acceleration during free fall
(b) Negative when the objects are thrown upwards
(c) Positive in both cases
(d) Only (a) and (b)

94. An object is thrown upwards and rises to the height of 10 m, which of the following is not correct.
(a) Initial velocity = $14\ ms^{-1}$
(b) Final velocity = $0\ ms^{-1}$
(c) Time taken to reach the highest point = 1.43 s
(d) Acceleration of the object = $+ 9.8\ ms^{-2}$

95. The weight of an object is the
(a) Mass of the object
(b) Force with which it is attracted towards the earth
(c) Product of its mass and acceleration due to gravity
(d) Only (b) and (c)

96. Weight on object weighing 10 kg on earth will become
(a) $1/6^{th}$ on the moon (b) $W_m = G\,M\,m / R_m^2$
(c) 98 N on moon (d) All of these

97. The force acting on an object perpendicular to the surface is called
(a) buoyancy (b) thrust
(c) surface Tension (d) None of these

98. Pressure is
(a) Thrust per unit area (b) Measured in $N\ m^{-2}$
(c) Measured in Pascal (d) All of these

99. Buoyant force is
(a) the upward force exerted by a liquid on an object
(b) known as up thrust
(c) force exerted by an object on the liquid
(d) Only (a) and (b)

100. Magnitude of the buoyant force depends on
(a) mass of the object (b) mass of the fluid
(c) density of the fluid (d) weight of the object

101. Select the correct statement :
(a) Objects of density less than that of a liquid will float on the liquid.
(b) Objects of density more than that of a liquid will sink in the liquid.
(c) Both (a) and (b)
(d) None of these

102. Archimedes principle states that :
(a) When a body is immersed fully or partially in a fluid, it experiences an upward force that is equal to the weight of the fluid displaced by it.
(b) When a body is floating on a liquid, it experiences a down ward force that is equal to the weight of the fluid under it
(c) When a body is immersed in a fluid, it experiences an upward force that is equal to the difference in their weights
(d) All are true

103. Relative density of a substance
(a) is described as the ratio of the density of a substance to that of air
(b) is described as the ratio of the density of a substance to that of water
(c) does not have any unit
(d) Both (b) and (c)

-

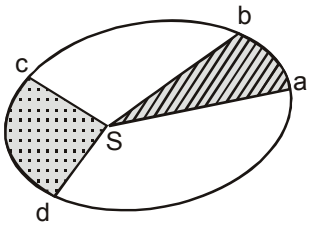
1. The relay satellite transmits the TV programme continuously from one part of the world to another because its
(a) period is greater than the period of rotation of the earth
(b) period is less than the period of rotation of the earth about its axis
(c) period has no relation with the period of the earth about its axis
(d) period is equal to the period of rotation of the earth about its axis

2. Geo-stationary satellite is one which
(a) remains stationary at a fixed height from the earth's surface
(b) revolves like other satellites but in the opposite direction of earth's rotation
(c) revolves round the earth at a suitable height with same angular velocity and in the same direction as earth does about its own axis
(d) None of these

3. If suddenly the gravitational force of attraction between earth and a satellite revolving around it becomes zero, then the satellite will
(a) continue to move in its orbit with same velocity
(b) move tangentialy to the original orbit in the same velocity
(c) become stationary in its orbit
(d) move towards the earth

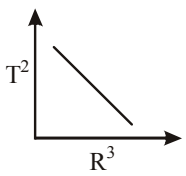
4. An artificial satellite orbiting the earth does not fall down because the earth's attraction
(a) is balanced by the attraction of the moon
(b) vanishes at such distances
(c) is balanced by the viscous drag produced by the atmosphere
(d) produces the necessary acceleration of its motion in a curved path

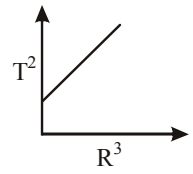
5. Figure shows the elliptical path of a planet around the sun. The two shaded parts have equal area. If t_1 and t_2 be the time taken by the planet to go from a to b and from c to d respectively, then

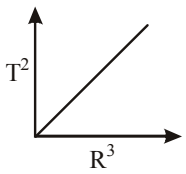


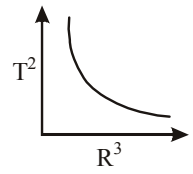
(a) $t_1 < t_2$ (b) $t_1 = t_2$ (c) $t_1 > t_2$
(d) insufficient information to deduce the relation between t_1 and t_2

6. Which of the following graphs represents the motion of a planet moving about the sun ?

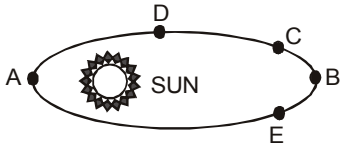
(a) 

(b) 

(c) 

(d) 

7. The planet mercury is revolving in an elliptical orbit around the sun as shown in fig. The kinetic energy of mercury will be greatest at
(a) A
(b) B
(c) C
(d) D



8. If the earth were to rotates faster than its present speed, the weight of an object will
(a) increase at the equator but remain unchanged at the poles

(b) decrease at the equator but remain unchanged at the poles
(c) remain unchanged at the equator but decrease at the poles
(d) remain unchanged at the equator but increase at the poles

9. The weight of an object in the coal mine, sea level and at the top of the mountain, are respectively W_1, W_2 and W_3 then
(a) $W_1 < W_2 > W_3$
(b) $W_1 = W_2 = W_3$
(c) $W_1 < W_2 < W_3$
(d) $W_1 > W_2 > W_3$

10. Consider Earth to be a homogeneous sphere. Scientist A goes deep down in a mine and scientist B goes high up in a balloon. The gravitational field measured by
(a) A goes on decreasing and that by B goes on increasing
(b) B goes on decreasing and that by A goes on increasing
(c) each decreases at the same rate
(d) each decreases at different rates

11. The free fall acceleration g increases as one proceeds, at sea level, from the equator toward either pole. The reason is
(a) Earth is a sphere with same density everywhere
(b) Earth is a sphere with different density at the polar regions than in the equatorial regions
(c) Earth is approximately an ellipsoid having its equatorial radius greater than its polar radius by 21 km
(d) Earth is apporximately an ellipsoid having its equatorial radius smaller than its polar by 21 km

12. Which one of the following statements about gravitational force is NOT correct?
(a) It is experienced by all bodies in the universe
(b) It is a dominant force between celestial bodies
(c) It is a negligible force for atoms
(d) It is same for all pairs of bodies in our universe

13. An artificial satellite orbiting the earth does not fall down because the earth's attraction
(a) is balanced by the attraction of the moon
(b) vanishes at such distances
(c) is balanced by the viscous drag produced by the atmosphere
(d) produces the necessary acceleration of its motion in a curved path

14. A ball is dropped from a satellite revolving around the earth at a height of 120 km. The ball will
(a) continue to move with same speed along a straight line tangentially to the satellite at that time
(b) continue to move with the same speed along the original orbit of satellite
(c) fall down to earth gradually
(d) go far away in space

15. If an apple is released from an orbiting spaceship, it will
(a) fall towards the Earth
(b) move at a lower speed
(c) move along with the spaceship at the same speed
(d) move at a higher speed

HINTS & EXPLANATIONS

Level-1

1. **(c)** **2.** **(c)** **3.** **(d)**

4. **(a)** The force that causes acceleration and keeps the body moving along the circular path is acting towards the center.

5. **(b)** **6.** **(a)** **7.** **(b)** **8.** **(a)**

9. **(d)** **10.** **(d)** **11.** **(a)**

12. **(d)** Universal law of gravitation states that every object in the universe attracts every other object with a force, which is proportional to the product of their masses and inversely proportional to the square of the distance between them.

13. **(d)** Kepler's laws governing the motion of planets are:

(a) The orbit of a planet is an eclipse with the Sun at one of the foci

(b) The line joining the planet and the Sun sweep equal areas in equal intervals of time

(c) The cube of the mean distance of a planet (r) from the Sun is proportional to the square of its orbital period (T).

14. **(a)** According to Kepler, force acting on an orbiting planet is given by $F \propto v^2 / r$.

15. **(a)** Gravitational constant $G = Fd^2 / M \times m$

16. **(a)**

17. **(b)** S.I. Unit of G is $N\,m^2\,kg^{-2}$

18. **(b)** **19.** **(a)**

20. **(b)** Value of $G = 6.673 \times 10^{-11}\ N\,m^2\,kg^{-2}$

21. **(d)**

22. **(c)** Gravitational force between the earth and an object on the surface of earth is best given by the formula $F = G \times M \times m / d^2$.

23. **(a)**

24. **(d)** Universal law of gravitation explains several unconnected phenomenon like the force that binds us to the earth, the motion of the moon around the earth or the planets around the Sun and also the formation of tides due to the moon and the Sun.

25. **(a)** Acceleration due to gravity for objects on or near the surface of the earth is represented as $g = G\,M / R^2$

26. **(b)** Since areal velocity $\vec{A}$ & angular momentum $\vec{L}$ of a planet are related by equation $\vec{A} = \frac{\vec{L}}{2M}$, where M is the mass of planet. Since in planetary motion $\vec{L}$ is constant ($\vec{\tau}_{ext.} = 0$), hence $\vec{A}$ is also constant.

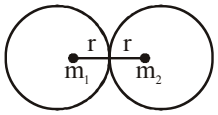
27. **(b)**

28. **(c)** It is applicable to both small & big bodies.

29. **(c)** The gravitational force of attraction between two identical spheres of radius r is

$$F = \frac{Gm_1m_2}{r^2} = \frac{G\frac{4}{3}\pi r^3\rho \times \frac{4}{3}\pi r^3\rho}{(2r)^2}$$

$$= \frac{4}{9}\pi^2 p^2 r^4$$



ie. $F \propto r^4$

30. **(a, d)** Same force acts on both masses

Hence $a \propto \frac{1}{m}$ $(F = ma)$

In absence of external force (remember mutual gravitational force is an internal force for the system) total energy remains constant.

31. **(a)** **32.** **(c)**

33. **(a)** The two air bubbles in water attract each other. The mass of air bubble in water (denser medium in comparision to air) behave like a negative mass as far as gravitational attraction is concerned. The absolute value of mass of bubble in water is equal to the mass of an equal volume of water. So by Newton' Law of gravitation

$$\vec{F} = G\frac{m_1m_2}{r^2}\hat{r}$$

but in water $\vec{F} = \frac{G(-m_1)(-m_2)}{r^2}\hat{r} = \frac{Gm_1m_2}{r^2}\hat{r}$

It means that force has attractive nature between two air bubble in water.

34. **(d)** Tides occurs due to gravitational pull of moon on the earth & they have regular character. On new moon & full moon high tides occur.

35. **(a)**

36. **(a)** The weight (=mg) of the body at the centre of the earth is zero, because the value of g at centre is zero.

37. **(c)** Since $g = \frac{GM_e}{R_e^2}$ for earth.

At poles the earth is slightly flattened. It means that the radius of earth at poles is slightely less in comparison to radius at equator. So from the above expression, the value of 'g' at poles is greater in comparison to value of 'g' at equator.

38. **(d)**

39. **(b)** At poles, the effect of rotation is zero and also the distance from the centre of earth is least.

40. **(a)**

41. **(a)** The orbital velocity of satellite near the earth surface is $v_0 = \sqrt{gR_e}$

$g = 9.8\ m/sec^2$, $R_e = 6.4 \times 10^6$ metre

$\Rightarrow v_0 = 7.92 \times 10^3 m/sec = 7.92\ km/sec \approx 8km/sec$

42. **(b)** The escape velocity of an object from any planet is

$v_{escape} = \sqrt{2gR} = \sqrt{2GM/R}$

Where R & M are the radius & mass of the planet.