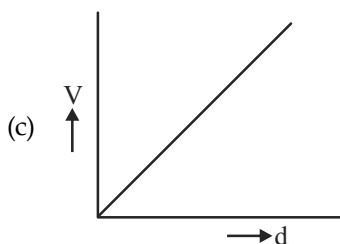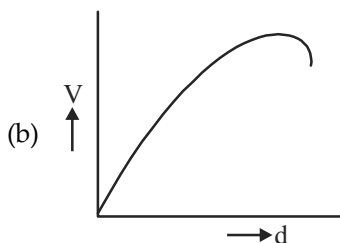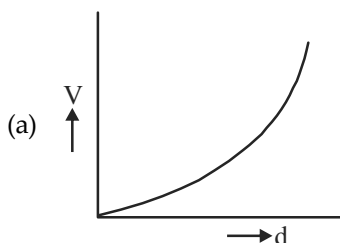**Chapter 1**

Physics

A. Mechanics

1. A parachutist jumps from a height of 5000 metre. The relationship between his falling speed, v and the distance fallen through d is best represented as : *[1995]*

(a)

(b)

(c)

(d)
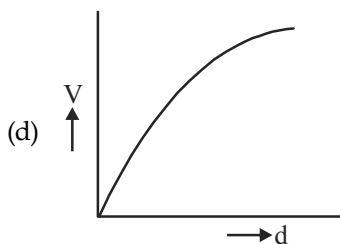
2. Who among the following anticipated Newton by declaring that all things gravitate to the earth? *[1995]*
(a) Aryabhatta   (b) Varahamihira
(c) Buddhagupta   (d) Brahmagupta

3. A liquid is flowing in a streamlined manner through a cylindrical pipe. Along a section containing the axis of the pipe, the flow profile will be :   *[1996]*

(a)

(b)

(c)

(d)
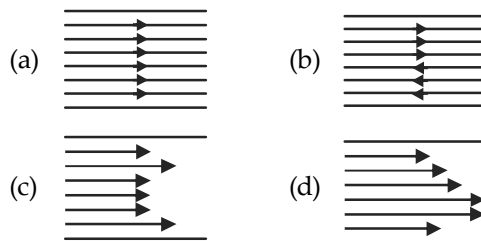
4. The variation of displacement d with time t in the case of a particle falling freely under gravity from rest is correctly shown in graph: *[1996]*

(a) d

(b) d

(c) d

(d) d
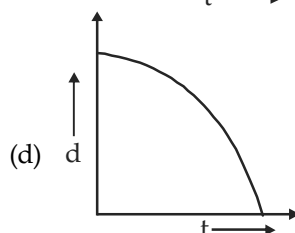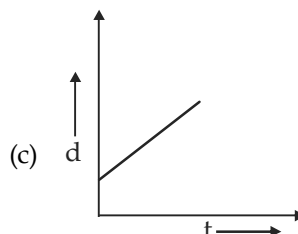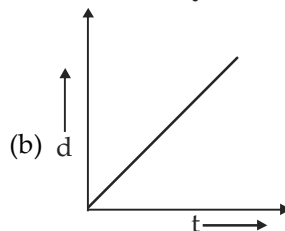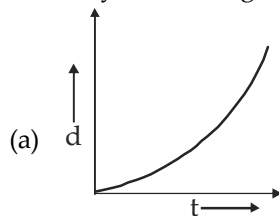
5. A simple machine helps a person in doing: *[1996]*
(a) less work
(b) the same amount of work with lesser force
(c) the same amount of work slowly
(d) the same amount of work much faster

6. The tendency of a liquid drop to contract and occupy minimum area is due to : *[1997]*
(a) surface tension   (b) viscosity
(c) density   (d) vapour pressure

7. Which one of the following is a vector quantity?
[1997]
(a) Momentum   (b) Pressure
(c) Energy   (d) Work

8. A girl is swinging on a swing in sitting position. When the girl stands up, the period of swing will :   *[1997]*
(a) be shorter
(b) be longer
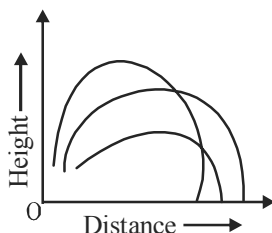(c) depends on the height of the girl
(d) not change

9. A boy standing at the point O in the given diagram throws a ball three times with the same force, but projecting it along different inclinations from the ground. The results of the throws have been plotted in the diagram. Which one of the following is a valid conclusion?   *[1997]*

(a) The larger the initial inclination, the longer the throw
(b) The larger the height reached, the longer the throw
(c) The larger the height reached, the shorter the throw
(d) The larger the initial inclination, the greater the height reached

10. The working principle of a washing machine is :
[1997]
(a) centrifugation   (b) dialysis
(c) reverse osmosis   (d) diffusion

11. A smooth plane inclined at an angle Q with the horizontal as shown in the given figure. A body starts from rest and slides down on the inclined surface. The time taken by the body to reach the bottom is:
[1997]
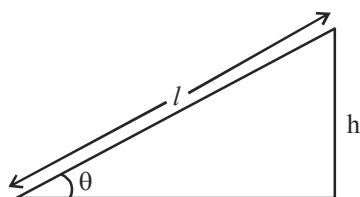
(a) $\sqrt{\dfrac{2h}{g}}$ (b) $\sqrt{\dfrac{2l}{g}}$

(c) $1/\sin\theta\sqrt{\dfrac{2h}{g}}$ (d) $\sin\theta\sqrt{\dfrac{2h}{g}}$

12. A ball is dropped from the top of a high building with a constant acceleration of 9.8 m/s². What will be its velocity after 2 seconds?   *[1998]*
(a) 9.8 m/s   (b) 19.6 m/s
(c) 29.4 m/s   (d) 39.2 m/s

13. A hunter aims his gun at a point between the eyebrows of a monkey sitting on a branch of a tree. Just as he fires, the monkey jumps down. The bullet will :
[1999]
(a) hit the monkey at the point aimed
(b) hit the monkey below the point aimed
(c) hit he monkey above the point aimed
(d) miss the monkey altogether

14. For which one of the following is capillarity not the reason?   *[1999]*
(a) Blotting of ink
(b) Rising of underground water
(c) Spread a water drop on a cotton cloth
(d) Rising of water from the roots of a plant to its foliage

15. Consider the following features of newer models of motor cars: *[2000]*
1. Radial tyres
2. Streamlined body
3. Multipoint fuel injection
4. Catalytic converter with exhaust
Which of these features make the new models of motor cars more fuel efficient?
(a) 1 and 2   (b) 2 and 3
(c) 2, 3 and 4   (d) 1, 3 and 4

16. **Assertion (A) :** A man standing on a completely frictionless surface can propel himself by whistling.
Reason (R) : If no external force acts on a system, its momentum cannot change.   *[2000]*
Codes:
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

17. The mass of a body on earth is 100 kg (acceleration due to gravity, $g_e = 10$ m/s². If acceleration due to gravity on the moon is $g_e/6$, then the mass of the body on the moon is :   *[2001]*
(a) 100/6 kg   (b) 60 kg
(c) 100 kg   (d) 600 kg

18. Consider the following statements: *[2001]*
    A simple pendulum is set into oscillation. Then:
    1. the acceleration is zero when the bob passes through the mean position.
    2. in each cycle the bob attains a given velocity twice.
    3. both acceleration and velocity of the bob are zero when it reaches its extreme position during the oscillation.
    4. the amplitude of oscillation of the simple pendulum decreases with time.
    Which of these statements are correct?
    (a) 1 and 2   (b) 3 and 4
    (c) 1, 2 and 4   (d) 2, 3 and 4

19. Which of the following distance-time graph *(x-t)* represents one-dimensional uniform motion? *[2001]*
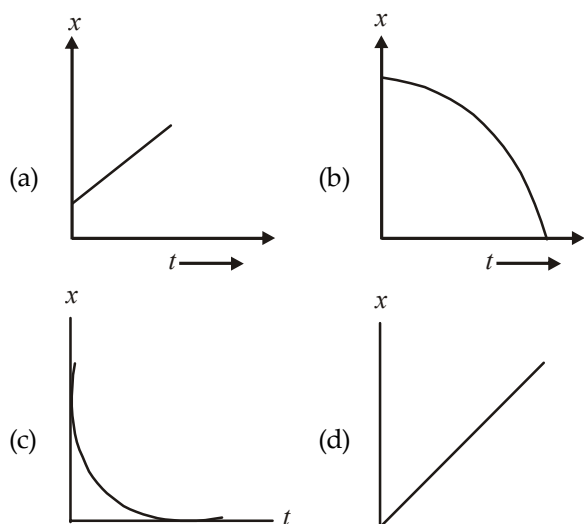
20. **Assertion (A) :** With the increase of temperature, the viscosity of glycerine increases. *[2002]*
    Reason (R) : Rise of temperature increases kinetic energy of molecules.
    Codes :
    (a) Both *A* and *R* are true and *R* is the correct explanation of *A*
    (b) Both *A* and *R* are true but *R* is not a correct explanation of *A*
    (c) *A* is true but *R* is false
    (d) *A* is false but *R* is true

21. **Assertion (A) :** An iron ball floats on mercury but gets immersed in water. *[2002]*
    Reason (R) : The specific gravity of iron is more than that of mercury.
    Codes:
    (a) Both *A* and *R* are true and *R* is the correct explanation of *A*
    (b) Both *A* and *R* are true but *R* is not a correct explanation of *A*
    (c) *A* is true but *R* is false
    (d) *A* is false but *R* is true

22. A solid cube gets completely immersed in water when a 0.2 kg mass is placed on it. If the mass is removed, the cube is 2 cm above the water level. What is the length of each side of the cube? *[2002]*
    (a) 12 cm   (b) 10 cm
    (c) 8 cm   (d) 6 cm

23. **Assertion (A) :** The weight of a body decreases with the increase of altitude on earth. *[2003]*
    Reason (R) : The earth is not a perfect sphere.
    Codes:
    (a) Both *A* and *R* are true and *R* is the correct explanation of *A*
    (b) Both *A* and *R* are true but *R* is not a correct explanation of *A*
    (c) *A* is true but *R* is false
    (d) *A* is false but *R* is true

24. Consider the following statements: *[2003]*
    A 4-wheel vehicle moving in a sharp circular path at high speed will :
    1. overturn about its outer wheels
    2. overturn about its inner wheels
    3. skid outwards
    4. skid inwards
    Which of these statements are correct?
    (a) 1 and 3   (b) 2 and 4
    (c) 2 and 3   (d) 1 and 4

25. An oil tanker partially filled with oil moves forward on a level road with uniform acceleration. The free surface of oil then: *[2003]*
    (a) remains horizontal
    (b) is inclined to the horizontal with smaller depth at the rear end
    (c) is inclined to the horizontal with larger depth at the rear end
    (d) assumes a parabolic curve

26. If the radius of the earth were to shrink by one per cent, its mass remaining the same, the value of *g* on the earth's surface would: *[2003]*
    (a) increase by 0.5%
    (b) increase by 2%
    (c) decrease by 0.5%
    (d) decrease by 2%

27. A car is running on a road at a uniform speed of 60 km/h. The net resultant force on the car is : *[2004]*
    (a) driving force in the direction of car's motion
    (b) resistance force opposite to the direction of car's motion
    (c) an inclined force
    (d) equal to zero

28. A spherical body moves with a uniform angular velocity (w) around a circular path of radius *r*. Which one of the following statements is correct? *[2004]*
    (a) The body has no acceleration
    (b) The body has a radial acceleration $\omega^2 r$ directed toward centre of path
    (c) The body has a radial acceleration $2/5\omega^2 r$ directed away from the centre of the path
   (d) The body has an acceleration ω^2 tangential to its path

29. A weightless rubber balloon is filled with 200 cc of water. Its weight in water is equal to :   *[2004]*
(a) 9.8/5 N   (b) 9.8/10 N
(c) 9.8/2 N   (d) zero

30. Which one of the following is the correct sequence of the given substances in the decreasing order of their densities?   *[2005]*
(a) Steel > Mercury > Gold
(b) Gold > Mercury > Steel
(c) Steel > Gold > Mercury
(d) Gold > Steel > Mercury

31. What is the approximate mean velocity with which the earth moves round the sun in its orbit?   *[2006]*
(a) 20 km/s   (b) 30 km/s
(c) 40 km/s   (d) 50 km/s

32. Four wires of same material and of dimensions as under are stretched by a load of same magnitude separately. Which one of them will be elongated maximum?   *[2007]*
(a) Wire of 1m length and 2 mm diameter
(b) Wire of 2 m length and 2 mm diameter
(c) Wire of 3 m length and 1.5 mm diameter
(d) Wire of 1 m length and 1 mm diameter

33. Three identical vessels A, B and C are filled with water, mercury and kerosene respectively up to an equal height. The three vessels are provided with identical taps at the bottom of the vessels. If the three taps are opened simultaneously, then which vessel is emptied first?   *[2007]*
(a) Vessel B
(b) All the vessels A, B and C will be emptied simultaneously
(c) Vessel A
(d) Vessel C

34. Consider the following statements :   *[2012 - I]*
If there were no phenomenon of capillarity
1. it would be difficult to use a kerosene lamp
2. one would not be able to use a straw to consume a soft drink
3. the blotting paper would fail to function
4. the big trees that we see around would not have grown on the Earth
Which of the statements given above are correct?
(a) 1, 2 and 3 only   (b) 1, 3 and 4 only
(c) 2 and 4 only   (d) 1, 2, 3 and 4

35. Ball bearings are used in bicycles, cars, etc., because   *[2013 - I]*
(a) the actual area of contact between the wheel and axle is increased
(b) the effective area of contact between the wheel and axle is increased
(c) the effective area of contact between the wheel and axle is reduced
(d) None of the above statements is correct

B. Heat and Thermodynamics

36. The clouds float in the atmosphere because of their low: *[1995]*
(a) temperature   (b) velocity
(c) pressure   (d) density

37. Strips of two metals *A* and *B* are firmly jointed together as shown in the figure.   *[1999]*

On heating, *A* expands more than *B* does. If this jointed strip is heated, then it will appear as

(a)

(b)

(c)

(d)
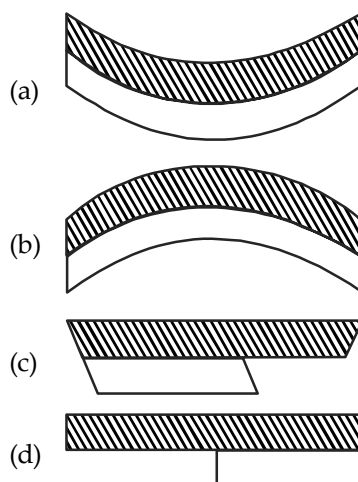
38. Low temperatures (cryogenics) find application in :   *[1999]*
(a) space travel, surgery and magnetic levitation
(b) surgery, magnetic levitation and telemetry
(c) space travel, surgery and telemetry
(d) space travel, magnetic levitation and telemetry

39. **Assertion (A) :** A piece of copper and a piece of glass are heated to the same temperature. When touched, thereafter, the copper piece appears hotter than the glass piece.
Reason (R) : The density of copper is more than that of glass.   *[2001]*
Codes:
(a) Both *A* and *R* are true and *R* is the correct explanation of *A*
(b) Both *A* and *R* are true but *R* is not a correct explanation of *A*
(c) *A* is true but *R* is false
(d) *A* is false but *R* is true

40. **Assertion (A) :** The boiling point of water decreases as the altitude increases.
Reason (R) : The atmospheric pressure increases with altitude.   *[2001]*
Codes :
(a) Both *A* and *R* are true and *R* is the correct explanation of *A*
(b) Both *A* and *R* are true but *R* is not a correct explanation of *A*
(c) *A* is true but *R* is false
(d) *A* is false but *R* is true

41. When water is heated from 0ºC to l0ºC. Its volume: *[2001]*
   (a) increases
   (b) decreases
   (c) does not change
   (d) first decreases and then increases

42. A hollow sphere of radius *R*, a hollow cube of side *R* and a thin circular plate of radius *R*, made up of the same material, are all heated to 20°C above room temperature. When left to cool in the room, which of them will reach the room temperature first? *[2002]*
   (a) Circular plate
   (b) Cube
   (c) Sphere
   (d) All of them will reach the room temperature at the same time

43. Consider the following statements: . *[2003]*
   1. Steam at 100°C and boiling water at 100°C contain same amount of heat.
   2. Latent heat of fusion of ice is equal to the latent heat of vaporization of water.
   3. In an air-conditioner, heat is extracted from the room air at the evaporator coils and is rejected out at the condenser coils.
   Which of these statements is/are correct?
   (a) 1 and 2   (b) 2 and 3
   (c) Only 2   (d) Only 3

44. Cloudy nights are warmer compared to clear cloudless nights, because clouds: *[2001]*
   (a) prevent clod waves from the sky from descending on earth
   (b) reflect back the heat given off by earth
   (c) produce heat and radiate it towards earth
   (d) absorb heat from the atmosphere and send it towards earth

45. The surface of a lake is frozen in severe winter, but the water at its bottom is still liquid. What is the reason ? *[2011 - I]*
   (a) Ice is a bad conductor of heat.
   (b) Since the surface of the lake is at the same temperature as the air, no heat is lost.
   (c) The density of water is maximum at 4°C.
   (d) None of the statements (a), (b) and (c) given is correct.

C. Optics and Sound

46. When the same note is played on a sitar and a flute, the sound produced can be distinguished from each other because of the difference in : *[1995]*
   (a) pitch, loudness and quality
   (b) pitch and loudness
   (c) quality only
   (d) loudness only

47. Given below are two statements, one labelled as Assertion (A) and other labelled as Reason (R). *[1995]*

Assertion (A) : A diamond sparkles more than a glass imitation cut to the same shape.
Reason (R) : The refractive index of diamond is less than that of glass.
In context of the above two statements, which one of the following is correct?
   (a) Both *A* and *R* are true and *R* is the correct explanation of *A*
   (b) Both *A* and *R* are true and *R* is not a correct explanation of *A*
   (c) *A* is true but *R* is false
   (d) *A* is false but *R* is true

48. Optical fibre works on the principle of : *[1995]*
   (a) total internal reflection
   (b) refraction
   (c) scattering
   (d) interference

49. Suppose a rocketship is receding from the earth at a speed of 2/10 th the velocity of light. A light in the rocketship appears blue to the passengers on the ship. What colour would it appear to an observer on the earth? *[1995]*
   (a) Blue   (b) Orange
   (c) Yellow   (d) Yellow-orange

50. An air bubble in water will act like a : *[1995]*
   (a) convex mirror   (b) convex lens
   (c) concave mirror   (d) concave lens

51. When a mirror is rotated by an angle θ, the reflected ray will rotate by : *[1996]*
   (a) 0°   (b) θ/2
   (c) θ   (d) 2θ

52. Total internal reflection can take place when light travels from: *[1996]*
   (a) diamond to glass (b) water to glass
   (c) air to water   (d) air to glass

53. Match List I (Quantity) with List II (Units) and select the correct answer using the codes given below the lists: *[1999]*

List-I		List-II	
A.	High speed	1.	Mach
B.	Wavelength	2.	Angstrom
C.	Pressure	3.	Pascal
D.	Energy	4.	Joule

Codes:
   (a) A-2, B-1, C-3, D-4
   (b) A-1, B-2, C-4, D-3
   (c) A-1, B-2, C-3, D-4
   (d) A-2, B-1, C-4, D-3

54. Consider the following statements: *[1999]*
   1. If a person looks at a coin which is in a bucket of water, the coin will appear to be closer than it really is.
   2. If a person under water looks at a coin above the water surface, the coin will appear to be at a higher level than it really is.

Which of the above statements is/are correct?

(a) 1 and 2   (b) 1 alone

(c) 2 alone   (d) neither 1 nor 2

55. A noise level of 100 decibel would correspond to:

[2000]

(a) Just audible sound

(b) Ordinary conversation

(c) Sound from a noisy street

(d) Noise from a machine shop

56. **Assertion (A) :** In a motion picture, usually 24 frames are projected every second over the whole length of the film.

Reason (R) : An image formed on the retina of eye persists for about 0.1 s after the removal of stimulus.

[2000]

Codes:

(a) Both *A* and *R* are true and *R* is the correct explanation of *A*

(b) Both *A* and *R* are true but *R* is not a correct explanation of *A*

(c) *A* is true but *R* is false

(d) *A* is false but *R* is true

57. **Assertion (A) :** Small glass beads fixed on traffic signals glow brightly when light falls upon them.

Reason (R) : Light is totally reflected when the angle of incidence exceeds a certain critical value and light travelling in a denser medium is reflected from a rarer medium.

[2000]

Codes :

(a) Both *A* and *R* are true and *R* is the correct explanation of *A*

(b) Both *A* and *R* are true but *R* is not a correct explanation of *A*

(c) *A* is true but *R* is false

(d) *A* is false but *R* is true

58. When a CD (compact disc used in audio and video systems) is seen in sunlight, rainbow like colours are seen. This can be explained on the basis of the phenomenon of :   *[2000]*

(a) reflection and diffraction

(b) reflection and transmission

(c) diffraction and transmission

(d) refraction, diffraction and transmission

59. **Assertion (A) :** A stick is dipped in water in a slanting position. If observed sideways, the stick appears short and bent at the surface of water.

Reason (R) : A light coming from the stick undergoes scattering from water molecules giving the stick a short and bent appearance.   *[2001]*

(a) Both *A* and *R* are true and *R* is the correct explanation of *A*

(b) Both *A* and *R* are true but *R* is not a correct explanation of *A*

(c) *A* is true but *R* is false

(d) *A* is false but *R* is true

60. When light waves pass from air to glass, the variables affected are: *[2001]*

(a) wavelength, frequency and velocity

(b) velocity and frequency

(c) wavelength and frequency

(d) wavelength and velocity

61. Consider the following statements: *[2002]*

1. Light of longer wavelength are scattered much more than the light of shorter wavelength.

2. The speed of visible light in water is 0.95 times the speed in vacuum.

3. Radio waves are produced by rapidly oscillating electrical currents.

4. To detect the overspeeding vehicles, police use the Doppler effect of reflected short radio waves.

Which of these statements are correct?

(a) 1 and 2   (b) 1 and 3

(c) 2 and 4   (d) 3 and 4

62. Consider the following natural phenomena: *[2002]*

1. Terrestrial heating

2. Reflection of light

3. Refraction of light

4. Diffraction of light

Due to which of these phenomena is a mirage formed ?

(a) 1 and 2   (b) 2, 3 and 4

(c) 1 and 3   (d) 4 only

63. Diffusion of light in the atmosphere takes place due to :

[2003]

(a) carbon dioxide

(b) dust particles

(c) helium

(d) water vapours

64. Which one of the following statements is not correct?

[2003]

(a) The velocity of sound in air increases with the increase of temperature

(b) The velocity of sound in air is independent of pressure

(c) The velocity of sound in air decreases as the humidity increases

(d) The velocity of sound in air is not affected by the change in amplitude and frequency

65. In which one among the following is the speed of sound maximum?   *[2006]*

(a) Air at 0°C   (b) Air at 100°C

(c) Water   (d) Wood

66. Consider the following statements: *[2007]*

1. If magenta and yellow coloured circles intersect, the intersected area will have red colour.

2. If cyan and magenta coloured circles intersect, the intersected area will have blue colour.

Which of the statements given above is/are correct?

(a) 1 only   (b) 2 only

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

67. Consider the following statements: *[2007]*
    1. A flute of smaller length produces waves of lower frequency.
    2. Sound travels in rocks in the form of longitudinal elastic waves only.
    Which of the statements given above is/are correct?
    (a) 1 only (b) 2 only
    (c) Both 1 and 2 (d) Neither 1 nor 2

68. **Assertion (A) :** A jet aircraft moving at Mach Number equal to 1 travels faster at an altitude of 15 km than while moving at Mach Number equal to 1 near the sea level.
    Reason (R) : The velocity of sound depends on the temperature of the surrounding medium. *[2007]*
    (a) Both A are R are true and R is the correct explanation of A
    (b) Both A and R are true but R is not a correct explanation of A
    (c) A is true but R is false
    (d) A is false but R is true

69. **Assertion (A):** Radio waves bend in a magnetic field.
    Reason (R): Radio waves are electromagnetic in nature. *[2008]*
    (a) Both A are R are true and R is the correct explanation of A
    (b) Both A and R are true but R is not a correct explanation of A
    (c) A is true but R is false
    (d) A is false but R is true

70. Which one of the following types of waves are used in a night vision apparatus? *[2009]*
    (a) Radio waves (b) Microwaves
    (c) Infra-red waves (d) None of the above

71. Consider the figure given below and answer the item that follows:
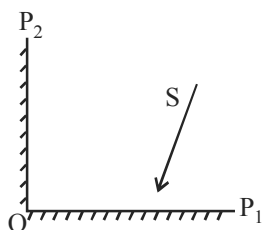
    In the figure shown above, OP$_1$ and OP$_2$ are two plane mirrors kept perpendicular to each other. S is the direction of a beam of light falling on the mirror OP$_1$. The direction of the reflected beam of light from the mirror OP$_2$ will be: *[2011 - II]*
    (a) Perpendicular to the direction S.
    (b) At 45° to the direction S.
    (c) Opposite and parallel to the direction S.
    (d) At 60° to the direction S.

72. Consider the following phenomena: *[2013 - I]*
    1. Size of the sun at dusk.
    2. Colour of the sun at dawn
    3. Moon being visible at dawn
    4. Twinkle of stars in the sky
    5. Polestar being visible in the sky
    Which of the above are optical illusions?
    (a) 1, 2 and 3 (b) 3, 4 and 5
    (c) 1, 2 and 4 (d) 2, 3 and 5

73. Rainbow is produced when sunlight falls on drops of rain. Which of the following physical phenomena are responsible for this? *[2013 - I]*
    1. Dispersion 2. Refraction
    3. Internal reflection
    Select the correct answer using the codes below.
    (a) 1 and 2 only (b) 2 and 3 only
    (c) 1 and 3 only (d) 1, 2 and 3

74. During a thunderstorm, the thunder in the skies is produced by the *[2013 - I]*
    1. meeting of cumulonimbus clouds in the sky
    2. lightning that separates the nimbus clouds
    3. violent upward movement of air and water particles
    Select the correct answer using the codes given below.
    (a) 1 only
    (b) 2 and 3
    (c) 1 and 3
    (d) None of the above produces the thunder

D. Electricity and Magnetism

75. Given below are two statements, one labelled as Assertion (A) and the other labelled as Reason (R).
    Assertion (A): Transformer is useful for stepping up or stepping down voltages.
    Reason (R): Transformer is a device used in D.C. circuits.
    In the context of the above two statements, which one of the following is correct? *[1996]*
    (a) Both *A* and *R* are true and *R* is the correct explanation of *A*
    (b) Both *A* and *R* are true but *R* is not a correct explanation of *A*
    (c) *A* is true but *R* is false
    (d) A is false but R is true

76. Domestic electrical wiring is basically a : *[1996]*
    (a) series connection
    (b) parallel connection
    (c) combination of series and parallel connections
    (d) series connection within each room and parallel connection elsewhere

77. Which one of the following is paramagnetic in nature? *[1997]*
    (a) Iron (b) Hydrogen
    (c) Oxygen (d) Nitrogen

78. A fuse is used in mains electric supply as a safety device. Which one of the following statements about the fuse is correct? *[1998]*
    (a) It is connected in parallel with the main switch
    (b) It is made mainly from silver alloys
    (c) It must have a low melting point
    (d) It must have very high resistance

79. **Assertion (A) :** The temperature of a metal wire rises when an electric current is passed through it. *[1998]*
    Reason (R) : Collision of metal atoms with each other releases heat energy.
    Codes:
    (a) Both *A* and *R* are true and *R* is the correct explanation of *A*
    (b) Both *A* and *R* are true but *R* is not a correct explanation of *A*
    (c) *A* is true but *R* is false
    (d) *A* is false but *R* is true

80. Consider the following statements: *[1999]*
    An ordinary light bulb has a rather short life because the:
    1. filament wire is not uniform.
    2. bulb cannot be evacuated completely.
    3. wires supporting the filament melt at high temperatures.
    Which of the above statements are correct?
    (a) 1 and 3   (b) 2 and 3
    (c) 1 and 2   (d) 1, 2 and 3

81. Consider the following statements regarding a motor car battery: *[1999]*
    1. The voltage is usually 12 V.
    2. Electrolyte used is hydrochloric acid.
    3. Electrodes are lead and copper.
    4. Capacity is expressed in ampere-hour.
    Which of the above statements are correct?
    (a) 1 and 2   (b) 2 and 3
    (c) 3 and 4   (d) 1 and 4

82. Fluorescent tubes are fitted with a choke. The choke coil : *[2000]*
    (a) steps up the line voltage
    (b) steps-down the line voltage
    (c) reduces current in the circuit
    (d) chokes low frequency current

83. Two wires have their lengths, diameters and resistivities all in the ratio of 1 : 2. If the resistance of the thinner wire is 10 ohm, the resistance of the thicker wire is : *[2001]*
    (a) 5 ohm   (b) 10 ohm
    (c) 20 ohm   (d) 40 ohm

84. **Assertion (A) :** In our houses, the current in A.C. electricity line changes direction 60 times per second.
    Reason (R) : The frequency of alternating voltage supplied is 50 Hz. *[2004]*

    (a) Both *A* and *R* are individually true and *R* is the correct explanation of *A*
    (b) Both *A* and *R* are individually true but *R* is not the correct explanation of *A*
    (c) *A* is true but *R* is false
    (d) *A* is false but *R* is true

85. What is the order of magnitude of electric resistance of the human body (dry) ? *[2005]*
    (a) 10^2 ohm   (b) 10^4 ohm
    (c) 10^6 ohm   (d) 10^8 ohm

86. Which one of the following is printed on a commonly used fluorescent tube light? *[2006]*
    (a) 220 K   (b) 273 K
    (c) 6500 K   (d) 9000 K

87. Graphene is frequently in news recently. What is its importance? *[2012 - I]*
    1. It is a two-dimensional material and has good electrical conductivity.
    2. It is one of the thinnest but strongest materials tested so far.
    3. It is entirely made of silicon and has high optical transparency.
    4. It can be used as 'conducting electrodes' required for touch screens, LCDs and organic LEDs.
    Which of the statements given above are correct?
    (a) 1 and 2 only
    (b) 3 and 4 only
    (c) 1, 2 and 4 only
    (d) 1, 2, 3 and 4

88. Electrically charged particles from space travelling at speeds of several hundred km/sec can severely harm living beings if they reach the surface of the Earth. What prevents them from reaching the surface of the Earth? *[2012 - I]*
    (a) The Earth's magnetic field diverts them towards its poles
    (b) Ozone layer around the Earth reflects them back to outer space
    (c) Moisture in the upper layers of atmosphere prevents them from reaching the surface of the Earth
    (d) None of the statements (a), (b) and (c) given above is correct

89. The known forces of nature can be divided into four classes, viz., gravity, electromagnetism, weak nuclear force and strong nuclear force. With reference to them, which one of the following statements is **not** correct? *[2013 - I]*
    (a) Gravity is the strongest of the four
    (b) Electromagnetism acts only on particles with an electric charge
    (c) Weak nuclear force causes radioactivity
    (d) Strong nuclear force holds protons and neutrons inside the nucleus of an atom

E. Modern Physics

90. The technique used to transmit audio signals in television broadcasts is : *[1995]*
   (a) Amplitude Modulation
   (b) Frequency Modulation
   (c) Pulse Code Modulation
   (d) Time Division Multiplexing

91. Consider the following statements: *[1996]*
   At the present level of technology available in India, solar energy can be conveniently used to :
   1. Supply hot water to residential buildings.
   2. Supply water for minor irrigation projects.
   3. Provide street lighting.
   4. Electrify a cluster of villages and small towns.
   (a) 1, 2, 3 and 4 are correct
   (b) 2 and 4 are correct
   (c) 1 and 3 are correct
   (d) 1, 2 and 3 are correct

92. One astronomical unit is the average distance between: *[1998]*
   (a) Earth and the Sun
   (b) Earth and the Moon
   (c) Jupiter and the Sun
   (d) Pluto and the Sun

93. For reproducing sound, a CD (Compact Disc) audio player uses a : *[2000]*
   (a) quartz crystal
   (b) titanium needle
   (c) laser beam
   (d) barium titanate ceramic

94. Which one of the following does a TV remote control unit use to operate a TV set? *[2000]*
   (a) Light waves   (b) Sound waves
   (c) Microwaves   (d) Radio waves

95. Consider the following statements: *[2001]*
   In a nuclear reactor, self-sustained chain reaction is possible, because:
   1. more neutrons are released in each of the fission reactions.
   2. the neutrons immediately take part in the fission process.
   3. the fast neutrons are slowed down by graphite.
   4. every neutron released in the fission reaction initiates further fission.
   Which of these statements are correct?
   (a) 1, 2 and 3   (b) 1 and 3
   (c) 2 and 4   (d) 2, 3 and 4

96. Consider the following statements: *[2005]*
   1. A geo-stationary satellite is at an approximate height of 10,000 km.
   2. FM transmission of music is of very good quality because the atmospheric or man made noises which are generally frequency variations can do little harm.

Which of the statements give above is/are correct?
   (a) 1 only   (b) 2 only
   (c) Both 1 and 2.   (d) Neither 1 nor 2

97. What does the term Dolby B or Dolby C printed on tape-recorders and other sound systems refer to: *[2006]*
   (a) frequency Modulated System
   (b) amplitude Modulated System
   (c) noise Reduction Circuit
   (d) both DC and AC power can be used

98. Which of the following types is used by computed tomography employed for visualisation of the internal structure of human body? *[2007]*
   (a) X-ray
   (b) South waves
   (c) Magnetic resonance
   (d) Radio isotopes

99. The efforts to detect the existence of Higgs boson particle have become frequent news in the recent past. What is/are the importance / importances of discovering this particle? *[2013 - I]*
   1. It will enable us to understand as to why elementary particles have mass.
   2. It will enable us in the near future to develop the technology of transferring matter from one point to another without traversing the physical space between them.
   3. It will enable us to create better fuels for nuclear fission.
   Select the correct answer using the codes given below.
   (a) 1 only   (b) 2 and 3 only
   (c) 1 and 3 only   (d) 1, 2 and 3

100. With reference to 'fuel cells' in which hydrogen-rich fuel and oxygen are used to generate electricity. Consider the following statements : *[2015-I]*
   1. If pure hydrogen is used as a fuel, the fuel cell emits heat and water as by-products.
   2. Fuel cells can be used for powering buildings and not for small devices like laptop computers.
   3. Fuel cells produce electricity in the form of Alternating Current (AC).
   Which of the statements given above is / are correct?
   (a) 1 only
   (b) 2 and 3 only
   (c) 1 and 3 only
   (d) 1, 2 and 3

F. Space Physics

101. Cryogenic engines find applications in : *[1995]*
   (a) sub-marine propulsion
   (b) frost-free refrigerators
   (c) rocket technology
   (d) research in superconductivity

102. Consider the following statements: *[1996]*
A person in a spaceship located half way between the earth and the sun will notice that the :
1.   sky is jet black.
2.   stars do not twinkle.
3.   temperature outside the spaceship is much higher than that on the surface of the earth.
(a) 3 alone is correct   (b) 1 and 2 are correct
(c) 1 and 3 are correct (d) 1, 2 and 3 are correct

103. The tail of a comet is directed away from the sun because: *[1997]*
(a) as the comet rotates around the sun, the lighter mass of the comet is pushed away due to the centrifugal force alone
(b) as the comet rotates, the lighter mass of the comet is attracted by some stars situated in the direction of its tail
(c) the radiation emitted by the sun exerts a radial pressure on the comet throwing its tail away from the sun
(d) the tail of the comet always exists in the same orientation

104. A 'black hole' is a body in space which does not allow any radiation to come out. This property is due to its:
                                                                 [2000]

(a) very small size   (b) very large size
(c) very high density (d) very low size

105. Consider the following statements in respect of India advanced satellite INSAT–4A: *[2006]*
1.   INSAT-4A was launched in December, 2005 from New Mexico.
2.   The European Commercial Launch Service Provider Arianespace was associated with the launch of INSA T-4A.
3.   Tata-Sky; a digital cable service provider; is associated with DTH television broadcasting service from INSA T 4A.
Which of the statements given above are correct?
(a) 1, 2 and 3   (b) 1 and 2 only
(c) 2 and 3 only   (d) 1 and 3 only

106. In which of the following activities are Indian Remote Sensing (IRS) satellites used?   *[2015-I]*
1.   Assessment of crop productivity
2.   Locating groundwater resources
3.   Mineral exploration
4.   Telecommunications
5.   Traffic studies
Select the correct answer using the code given below.
(a) 1, 2 and 3 only   (b) 4 and 5 only
(c) 1 and 2 only   (d) 1, 2, 3, 4 and 5

HINTS & SOLUTIONS

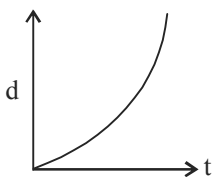## A. Mechanics

1. **(d)** When a parachutist jumps from a height, its speed first increases with the distance fallen and then becomes constant. So, the graph given in option (d) best represents the given situation.

2. **(d)** Brahmagupta was an Indian mathematician and astronomer who had written numerous important books on mathematics and astronomy. He anticipated Newton by declaring that all things gravitate to the earth.

3. **(a)** If a fluid flows such that its velocity at a point is always the same in magnitude and direction, the fluid is said to have a streamline flow. The type of flow in a fluid system is characterized by the presence of laminae, or parallel streams of fluid. A streamline is a straight or curved path such that tangent to it at a point gives the direction of flow of liquid at that point. Thus, according to question the flow profile is best represented by figure (a).

4. **(a)** As

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

$u = 0$ (given)

$d = \frac{1}{2} gt^2$

$d \propto t^2$

5. **(b)** A simple machine is a mechanical device that changes the direction or magnitude of a force. In general, they can be defined as the simplest mechanisms that use mechanical advantage to multiply force. Thus, simple machine helps us in doing same amount of work with lesser force. Few examples of simple machines are pulley, lever ,wheel, screw, etc.

6. **(a)** It is observed that liquid drop tend to contract and appear spherical when it is set free from external forces like gravity, etc. Surface tension is the property among liquids due to which they tend to occupy minimum surface area. That's why water droplet appears spherical because for a given volume, a sphere has minimum surface area. Due to this property of surface tension liquid surface stretches and behaves like a stretched membrane.

7. **(a)** Scalars are quantities that have magnitude only; they are independent of direction. Vectors have both magnitude and direction. Momentum is the product of the mass and velocity of an object ($p = mv$). Momentum is a vector quantity, since it has a direction as well as a magnitude. The rest of quantities in option pressure, work and energy have magnitude but not direction.

8. **(a)** Effective length is the length of point of suspension to the centre of gravity(mass) of a body. Let it be ℓ when the girl is sitting and ℓ' when girl stands up. Here $\ell > \ell'$. Thus, the time period of swing will decrease because time period of swing is given by formula
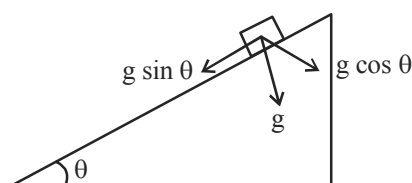
$$T = 2\pi\sqrt{\frac{l}{g}}$$

So, it is clear from above formula that the time period of system is directly proportional to effective length.

9. **(d)** The above diagram represents a body in projectile motion

Maximum height $y_{max} = \dfrac{v^2 \sin^2 \theta}{2g}$

Thus, according to above equation greater the initial inclination, the greater is the height reached.

10. **(a)** Washing machine works on the principle of centrifugation. Centrifugation is a process that involves the use of the centrifugal force for the separation of mixtures with a centrifuge, used in industry and in laboratory settings. More-dense components of the mixture migrate away from the axis of the centrifuge, while less-dense components of the mixture migrate towards the axis.

11. **(c)** An object on an inclined plane with inclination θ moves with an acceleration g sin θ down the plane. The time taken to reach the bottom is given by

$l = \dfrac{1}{2}at^2$ (as u = 0)

$\Rightarrow \quad t = \sqrt{\dfrac{2l}{a}} = \sqrt{\dfrac{2l}{g\sin\theta}} = \sqrt{\dfrac{2 \times h}{g\sin\theta \times \sin\theta}}$

$\therefore \quad t = \dfrac{1}{\sin\theta}\sqrt{\dfrac{2h}{g}}$

12. **(b)** The velocity after time t is given by
$$v = u + gt$$
Here, $u = 0$, $t = 2$s, $g = 9.8$ m/s^2
$\therefore \quad v = 0 + (9.8 \times 2) = 19.6$ m/s

13. **(a)** As monkey and bullet both fall under the same gravitational force, so bullet will hit exactly the same point it has been aimed.

14. **(b)** Capillary action, or capillarity, is a phenomenon where liquid spontaneously rises in a narrow space such as a thin tube, or in porous materials such as paper or in some non-porous materials such as liquified carbon fibre. This effect can cause liquids to flow against the force of gravity or the magnetic field induction. In blotting of ink, spread of water drop on a cotton cloth and the rising of water from the roots of a plant to its foliage.

15. **(b)** A "streamlined" design is one in which objects that move through a gas or liquid are shaped to match these lines, and therefore, reduce the energy required to produce that motion. Multi point fuel injection system injects fuel into individual cylinders, based on commands from the 'on board engine management system computer—popularly known as the Engine Control Unit/ECU. These techniques result not only in better 'power balance' amongst the cylinders but also in higher output from each one of them, along with faster throttle response. The other two options radial tyres and catalytic converter with exhaust do not contribute to make the car more fuel efficient.

16. **(b)** First statement can be explained on the basis of laws of motion. First statement involves the use of Newton's third law of motion, "For every action there is an equal and opposite reaction". In first case while whistling a man uses his breathe as a propellant to propel himself. The second statement can be explained on the basis of law of conservation of linear momentum according to which the momentum of body remains conserved until any external force acts upon it.

17. **(c)** Mass is a universal constant. The mass of a body remains unchanged in any part of universe. Mass of a body does not change with respect to gravity. It is the weight that changes with gravity.

18. **(c)** The bob of a simple pendulum is attached to a string which pulls the bob along its length.
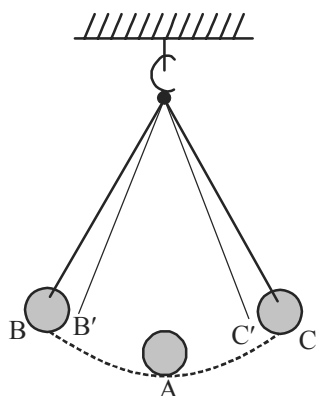
Here B and C are extreme positions whereas A is mean position. The speed of the bob increases as it approaches the mean position A and continues to move till it reaches C. At C the speed becomes zero. Due to the unbalanced force the bob moves towards the mean position. The speed of the bob is maximum at the mean position and is zero at the extreme positions. Thus, it is clear that in each cycle bob velocity increases from zero to maximum. This means that it attains a given velocity twice. Suppose the bob of the pendulum reaches up to B while oscillating, then AB is the amplitude. For the next oscillation the bob fails to reach B but it will reverse the direction from point B' instead of B. The amplitude of oscillation in the second case is AB' which is less than AB. That means, a retarding force is acting on the bob thereby reducing the amplitude of oscillation. This retarding force is nothing but air-resistance or air-friction. At extreme position, acceleration is maximum. So statement 3 is not correct.

19. **(d)** Figure (d) correctly represents the time-distance graph for one dimensional uniform motion.

20. **(d)** Statement 1 is false. The temperature dependence of liquid viscosity is the phenomenon by which liquid viscosity tends to decrease (or, alternatively, its fluidity tends to increase) as its temperature increases. Thus, with increase of temperature viscosity of glycerine decrease. Statement 2 is correct because with the rise of temperature in case of liquid, the kinetic energy increases as kinetic energy of liquid molecules is directly proportional to absolute temperature.

21. **(c)** Statement 1 is true but statement 2 is false. Specific gravity is the ratio of the density (mass of a unit volume) of a substance to the density (mass of the same unit volume) of a reference substance. Mercury has a specific gravity of 13.56 whereas specific gravity of iron is 7.21.Thus, iron ball floats on mercury.

22. **(b)** The volume of 2 cm part of the cube, assuming the side of cube is x.
Volume = $2 \times x \times x = 2x^2$
Mass displaced by this portion = 0.2 kg = 200 gm
Using

Mass = Volume × density
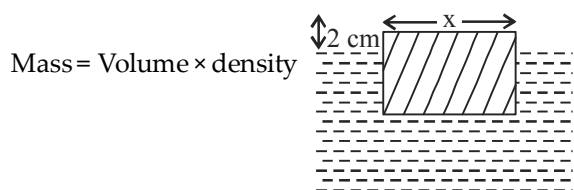
  200 = $2x^2 \times 1$
   $x^2 = 100$
    x = 10 cm

23. **(b)** Weight is basically the measurement of the gravitational force that acts on an object. Weight of any body is given by formula
$$W = mg$$
m is the mass of body.
g refers to the acceleration that the Earth imparts to objects on or near its surface. It is called acceleration due to gravity.

Now, mass is universal constant. It will remain same at earth surface or at any point above the surface of earth. Acceleration due to gravity decreases with altitude, since greater altitude means greater distance from the Earth's centre.

The following formula approximates the Earth's gravity formula variation with altitude:

$$g_r = g_o \left(\frac{re}{r_e + h} \right)^2$$

Where

$g_r = \bullet$ is the gravity measure at height above sea level.

$r_e = \bullet$ is the Earth's mean radius.

$g_o = \bullet$ is the standard gravity.

Earth is not a perfect sphere because its two poles cause it to bulge out in the middle. It spins on its axis and the centrifugal force makes the part at the equator bulge out slightly.

24. **(a)** In case of object moving along a circular path two types of forces centripetal and centrifugal acts upon it. As they have opposite impact thus, the object remains in balance. When centrifugal force gets disturbed then the object will leave the balance and skid toward an outward direction.

25. **(c)** The surface of tanker will move in forward direction with increasing velocity (as acceleration in uniform), so depth will be larger at the rear end.

26. **(b)** The value of g on earth's surface is given by

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

$$\Rightarrow \quad \frac{\Delta g}{g} = -2 \left(\frac{\Delta R}{R} \right) \text{ (if } M \text{ is constant)}$$

Thus, if radius of the earth shrinks by 1%, the value of g will increase by 2%.

27. **(d)** By Newton's second law F = ma. If $a = 0$, $F_{net} = 0$ Thus, the resultant force is zero.

28. **(b)** A body moving with a uniform angular velocity ω on a circular path of radius r has radial acceleration equal $\omega^2 r$ directed towards the centre of the path.

29. **(d)** In this case, balloon is filled up with water and then put into water. Initially, after some oscillations it become stable because the downward directing force exerted by weight of water in balloon is balanced by the upward directing buoyancy force of water. Hence, the resultant weight in water is zero as there is no resultant force acting upon it.

30. **(b)** Density of gold is 19.30 g/cm^3. The density of ultra pure liquid mercury is 13.534 g/cm^3 and the density of steel is 7.80 g/cm^3.

31. **(b)**

32. **(c)** Elongation (Δl) in a wire is given by

$$Y = \frac{F}{A} \times \frac{l}{\Delta l}$$

$$\Rightarrow \quad \Delta l = \frac{Fl}{AY}$$

For wires of same material and same load,

$$\Delta l \propto \frac{l}{A} \Rightarrow \Delta l \propto \frac{l}{r^2}$$

Therefore, the extensions will be maximum in case of the wire with length 3 m and diameter 1.5 mm.

33. **(d)** Viscocity of Kerosene is alert among all, so it will emptied first.

34. **(b)**
   1. it would be difficult to use a kerosene lamp
   3. the blotting paper would fail to function
   4. the big trees that we see around would not have grown on the Earth

35. **(c)** Ball bearings are used to reduce friction and friction is directly propertional to effective surface area. So if effective surface area is reduced then friction will also reduce.

B. Heat and Thermodynamics

36. **(d)** Because of density. The density of the clouds is less than that of the air. Same phenomena is there behind this, according to which is ship float in a sea.

37. **(b)** Thermal expansion is the tendency of matter to change in volume in response to a change in temperature. In this case A expands more than B. Therefore, expansion of volume will be more for A in comparison to B on application of same amount of heat. Therefore, on heating it will appear like figure (b).

38. **(a)** In physics, cryogenics is the study of the production of very low temperature (below –150 °C, – 238 °F or 123 K) and the behavior of materials at those temperatures. Application of cryogenics are in MRI.

MRI is a method of imaging objects that uses a strong magnetic field to detect the relaxation of protons that have been perturbed by a radio-frequency pulse. This magnetic field is generated by electromagnets, and high field strengths can be achieved by using superconducting magnets. Traditionally, liquid helium is used to cool the coils because it has a boiling point of around 4 K at ambient pressure.

Cryogenic liquids are also used in the space program. For example, cryogens are used to propel rockets into space. A tank of liquid hydrogen provides the fuel to be burned and a second tank of liquid oxygen is provided for combustion.

Cryogenic processes are also used to supply "banks" storing eye corneas, blood, and sperm for future surgical procedures. In 1961 American surgeon Irving S. Cooper introduced a freezing technique called cryosurgery. Cryosurgery is relatively bloodless because the low temperatures used constrict the blood vessels, stemming the loss of blood.

39. (b) Both statement 1 and statement 2 are correct. On heating up to same temperature copper piece is found hotter than in comparison to glass piece because copper being a metal is a good conductor of heat and electricity while glass on the other hand is a poor conductor of heat. The density of copper is 8.92 gm/cm^3 and of glass is 2.6 gm/cm^3.

40. (c) The boiling point of an element or a substance is the temperature at which the vapour pressure of the liquid equals the environmental pressure surrounding the liquid. As altitude increases, atmospheric pressure decreases, so boiling point decreases, so the liquid would boil at a lower temperature.

41. (d) Initially at start of heating from 0°C to 4°C there will be a contraction as a result of which volume decreases. On further heating beyond 4°C to 10°C the molecules gain kinetic energy and start moving more randomly. Thus, intermolecular distance increases as a result of which its volume increases.

42. (c) The loss of heat is directly proportional to the surface area, hence loss of heat will be earlier in case of sphere because it has the maximum surface area.

43. (d) Only statement 3 is correct. An air conditioner (often referred to as AC) is a home appliance, system, or mechanism designed to dehumidify and extract heat from an area. Steam (at 100 degree Celsius) has more energy than water (at 100 degree Celsius) because it takes energy to break the bonds that keep it liquid. Latent heat is the heat released or absorbed by a chemical substance or a thermodynamic system during a change of state that occurs without a change in temperature. Latent heat of fusion of water is 334 kJ/kg whereas Latent heat of vaporization of water is 2260 kJ/kg.

44. (b) Cloudy nights are warmer than clear nights because, the cloud cover provides a shield which act as an insulator and store up the heat radiated by the earth and do not permit heat to escape.

45. (a) When temperature starts reducing in winter, lake water cools upto 4 degree centigrade by convection as density increase with reduction in temp. On further cooling, due to abnormal expansion of water, density reduces and cold water remains at top. Then top layer freezes. Ice being bad conductor of heat, lake water below ice remains at 4 degrees.

C. Optics and Sound

46. (c) Sounds may be generally characterized by pitch, loudness, and quality. Sound "quality" or "timbre" describes those characteristics of sound which allow the ear to distinguish sounds which have the same pitch and loudness. Quality is then a general term for the distinguishable characteristics of a tone.

47. (c) This is a phenomenon of total internal reflection of light, dependent on the `critical angle' of the incidence of light in a material medium at its bounding surface with air. The higher the refractive index of a transparent material the smaller is the critical angle and hence the larger is the range of angles of incidence for more light to be totally reflected. A diamond has a large refractive index and very small critical angle as against glass, which has a lower refractive index and large critical angle.

A skilled diamond cutter exploits the large range of angles of incidence in the diamond to cut multiple faces at suitable angles. Light entering diamond from different faces, suffers multiple total internal reflection and comes out of the diamond as intense beams from selected directions. Hence, a diamond shines brilliantly.

48. (a) An optical fibre is a thin, flexible, transparent fibre that acts as a waveguide or "light pipe" to transmit light between the two ends of the fibre. An optical fibre transmits light along its axis, by the process of total internal reflection. When light traveling in a dense medium hits a boundary at an angle larger than the "critical angle" for the boundary, the light will be completely reflected. This effect is used in optical fibres to confine light in the core.

49. (d) The observer on the earth will detect a wavelength given by

$$v = \pm \frac{\lambda - \lambda_0}{\lambda} c$$

where λ = original wavelength
         λ_0 = apparent wavelength
         v = velocity of source

Here, source is receding, therefore +ve sign will be taken

$$\therefore \frac{2}{10} c = \frac{\lambda - \lambda_0}{\lambda} c \Rightarrow \frac{\lambda - \lambda_0}{\lambda} = \frac{2}{10} \Rightarrow 1 - \frac{\lambda_0}{\lambda} = \frac{2}{10}$$

$$\Rightarrow \frac{\lambda_0}{\lambda} = 1 - \frac{2}{10} = \frac{8}{10} \Rightarrow \lambda = \frac{10}{8} \lambda_0 = 1.25 \lambda_0$$

The wavelength of blue light varies from 450 nm to 475 nm. Therefore, the observed light will have wavelength ranging from 562.5 nm to 593.75 nm which will be yellow orange.

50. (d) Air bubble in water would act as a diverging lens, because the index of refraction of air is less than that of water.

51. (d) Consider a plane-mirror and a fixed incident ray of light. Before the mirror has rotated, the angle of incidence is θ as is the angle of reflection. If the mirror is rotated through an angle ϕ the normal is rotated by an angle f and thus the angle of incidence increases to θ + ϕ. Therefore, the angle of reflection must also increase by ϕ to θ + ϕ. The difference between the final angle of reflection and the initial angle of reflection is 2ϕ. Thus for a fixed incident ray, the angle of the reflection is twice the angle through which the mirror has rotated.

52. **(a)** Total internal reflection is an optical phenomenon that happens when a ray of light strikes a medium boundary at an angle larger than a particular critical angle with respect to the normal to the surface. If the refractive index is lower on the other side of the boundary, no light can pass through and all light is reflected. The critical angle is the angle of incidence above which the total internal reflection occurs. Total internal reflection takes place when light travels from optically denser medium to optically rarer medium. Refractive index of diamond is very high (2.417) whereas refractive index of glass is only in between (1.5 to 1.6), whereas in rest all options there is no possibility of total internal reflection because refractive index of water (1.33) and air (1.0008) is less than refractive index of glass.

53. **(c)** Mach number (Ma or M) is the speed of an object moving through air, or any other fluid substance. It is commonly used to represent the speed of an object when it is travelling close to or above the speed of sound. Pressure is the force per unit area applied in a direction perpendicular to the surface of an object. The SI unit for pressure is the pascal (Pa), equal to one newton per square meter (N/m^2).

In physics, the wavelength of a sinusoidal wave is the spatial period of the wave—the distance over which the wave's shape repeats. The unit for wavelength is the angstrom.

In physics, energy is a quantity that is the ability to do work. In the International System of Units (SI), energy is measured in joules, but in some fields other units such as kilowatt-hours and kilocalories are also used.

54. **(a)** Refraction is the change in direction of a wave due to a change in its speed. This is most commonly observed when a wave passes from one medium to another at any angle other than 90° or 0°. Refraction of light is the most commonly observed phenomenon. In both cases the phenomenon of refraction is applicable because there will be a change in the direction and speed as light enters from one media to other. In case 1 light for observer outside water the light ray is travelling from denser medium (water) to rarer medium (air). Thus, image of coin will appear closer due to refraction. Whereas in case 2 for observer under water refraction also takes place but in opposite way as light travels from rarer medium (air) to denser medium (water) .Thus, the image of coin will appear at a higher level than actual position of coin.

55. **(d)** The decibel is widely known as a measure of sound pressure level, but is also used for a wide variety of other measurements in science and engineering. The decibel is commonly used in acoustics to quantify sound levels relative to a 0 dB reference which has been defined as a sound pressure level of .0002 microbar. The noise level of 100 decibel would corresponds to noise from a machine shop.

56. **(c)** A is correct but an image formed on the retina of eye persists for about $\frac{1}{16}$ sec (0.06 sec) after it changes.

57. **(a)** Both of the statements are correct and statement 2 is also correct explanation for statement 1. Total internal reflection is an optical phenomenon that happens when a ray of light strikes a medium boundary at an angle larger than a particular critical angle with respect to the normal to the surface. If the refractive index is lower on the other side of the boundary, no light can pass through and all of the light is reflected. Thus because of this phenomena traffic light beads glow when light falls on them.

58. **(d)** The reason CDs reflect rainbow colors is because they have a clear plastic coating on top of a mirrorized surface. Light refracts (bends) when it moves from one medium (such as air) to another with a different optical density (such as the clear plastic surface of a CD). Different wave lengths of light (every color has a different wave length) travel at different speeds, so that full spectrum appears when white light passes from the air through the plastic surface of a CD, separated light rays which are then reflected back to us by the mirrorized center surface of a CD. Here the diffraction and transmission also takes place because diffraction of light rays occur when it strikes the surface of CD and transmission is obvious when light enters from one medium to another. The thickness of the different optical media, angle of source light, and brightness of source light all affect which rainbow patterns are visible on a CD.

59. **(c)** Statement 1 is true but statement 2 is false. Yes the stick dipped in water appears to be bent and short but refraction of light by water molecules is the phenomena responsible for this observation not because of scattering of light.

60. **(d)** When light enters from rarer (air) to denser (glass) medium wavelength and velocity will get affected. The velocity will decrease. Moreover, as the ray bent in passing through different media which results in decrease of wavelength. As such there is no change in frequency when light enters from air to glass.

61. **(d)** Radio waves are a form of electromagnetic radiation, created whenever a charged object (in normal radio transmission, an electron) accelerates with a frequency that lies in the radio frequency (RF) portion of the electromagnetic spectrum. Thus statement 3 is correct. The Doppler's Effect shows a change in a wave's frequency received when it is either reflected from a moving object or generated on a moving object. Police radar speed detectors bounce a radio frequency wave off cars and use their internal electronics to determine the speed at which the object is moving by that frequency change. Therefore, statement 4 is also correct.

62. **(c)** Convection currents of hot air rising off a surface have a lower density than the air directly above it. The difference in density cause light passing through the air to refract differently, which causes the formation of mirage.

63. (b) Dust particles are responsible for the diffusion of light in atmosphere.

64. (c) The velocity of sound in air is determined by the air itself and is not dependent upon the amplitude, frequency, or wavelength of the sound. The velocity of sound c depends on the temperature of air and not on the air pressure. Thus, velocity of sound in air increases with temperature and remains unaffected with increase of pressure. Therefore, statements 1, 2 and 4 are right. Only statement 3 is wrong. The only other factor that has any effect on the speed of sound in air is the amount of humidity in the air. An increase in the amount of humidity in the air increases the speed by a small amount.

65. (d) The speed of sound is the distance travelled during a unit of time by a sound wave propagating through an elastic medium. In dry air at 20 °C (68 °F), the speed of sound is 343.2 metres per second (1,126 ft/s). In fresh water, sound travels at about 1497 m/s at 25 °C. The value of 331.3 m/s which represents the 0 °C speed. The speed of sound at 100 °C is 386 m/s. The speed of sound in wood is 3300 - 3600 m/s.

66. (c) Combination of red and blue colour results into formation of magenta colour. Where as combination of red and green colour results in to formation of yellow colour. Thus on combination of magenta and yellow colour red colour will be highlighted. On the other side combination of blue and green results into formation of cyan colour. Combination of red and blue colour produce magenta colour. Therefore, on combination of cyan and magenta colours blue colour will be more highlighted.

67. (b) The flute is a musical instrument of the woodwind family. A flute of smaller length produces waves of higher frequency. Sound waves travels through medium even through extremely dense medium like rocks in the form of longitudinal waves only. A good example is the shock wave from an Earthquake, which can be heard hundreds of miles away from the epicenter after travelling through rocks in the ground.

68. (d) Mach number, a useful quantity in aerodynamics, is the ratio of air speed to the local speed of sound. The speed of sound varies with temperature. Since temperature and sound velocity normally decrease with increasing altitude, sound is refracted upward. Mach number is a function of temperature at altitude. With decrease in sound velocity Mach number increases.

69. (d) Radio waves are a type of electromagnetic radiation.

70. (c) Night Vision as referenced here is that technology that provides us with the miracle of vision in total darkness and the improvement of vision in low light environments. Infra-red waves are used in night vision apparatus.

71. (c)
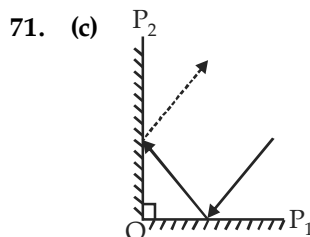
In the above figure, dotted line shows the reflected beam of light from mirror OP_2.

72. (c) Size of the Sun at dusk is an optical illusion because of atmospheric refraction. Colour of the sun appears yellow due to scattering whereas pure sunlight is white in colour. Twinkling of stars is an optical illusion. Air whirlpools make the stars twinkle.

73. (d) Formation of rainbow involves all dispersian, refraction and internal reflection.
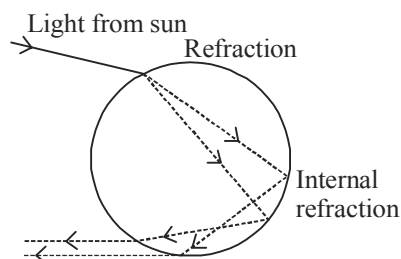
74. (d) Thunderstorms result from the rapid upward movement of warm, moist air. They can occur inside warm, moist air masses and at fronts. As the warm, moist air moves upward, it cools, condenses, and forms cumulonimbus clouds that can reach heights of over 20 km (12.45 miles). The thunderstorms are associated with the cumulonimbus clouds. These clouds normally form on warm sunny days but they can also be found on cold front. But this question is asking about the Thunder i.e. the sound produced. The lightning generates between 100 million and 1 billion volts of electricity and can heat the air to around 50K°F. The rapid expansion causes the shock waves. Thunder happens because the lightning would heat the air at huge temperatures and the air expands so fast that it make a loud clap of thunder.

D. Electricity and Magnetism

75. (c) A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors–the transformer's coils. A varying current in the first or primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic field through the secondary winding. This varying magnetic field induces a voltage in the secondary winding. By appropriate selection of the ratio of turns, a transformer thus allows an alternating current (AC) or voltage to be "stepped up" by making N_s greater than N_p or "stepped down" by making N_s less than N_p.
Here N_p represents number of turns in primary winding. N_s represents the number of turns in secondary winding.

As it is clear from principle involved that transformer can be used to step up and step down A.C. voltage only. This device can not be used for D.C. voltage as its working is based on the change of magnetic flux with varying current.

76. **(b)** In a parallel circuit, the voltage across each of the components is the same, and the total current is the sum of the currents through each component. The wiring for most homes is parallel .In parallel circuit each branch receives equal current. If one branch in the circuit is broken, electric current will still flow in other branches.

77. **(c)** Iron = Ferromagnetic
Hydrogen = Diamagnetic
Oxygen = Paramagnetic
Nitrogen = Diamagnetic

78. **(c)** A fuse is a type of sacrificial overcurrent protection device. Its essential component is a metal wire or strip that melts when too much current flows. Short circuit, overload or device failure is often the reason for excessive current. The resistance of the element used in fuse generates heat due to the current flow. It has low melting point so that it melts when a short-circuit or overloading takes place.

79. **(a)** A metallic conductor has a large number of free electrons in it. When a potential difference is applied across the ends of a metallic wire, the free electrons begin to drift from a region of low potential to a region of high potential. These electrons collide with the positive ions (the atoms which have lost their electrons). In these collisions, the energy of the electron is transferred to the positive ions and they begin to vibrate more violently. As a result, heat is produced. The greater the number of electrons flowing per second, the greater will be the rate of collisions and so greater is the heat produced.

80. **(d)** The electric light bulb uses a glowing wire filament heated by electrical resistance to white to generate light (a process known as thermal radiation). The 'bulb' is the glass enclosure which keeps the filament in a vacuum or low-pressure noble gas. Complete evacuation of bulb is not possible. A small quantity of gases left behind which expands on heating by heat through filament. Moreover, the wires supporting the filament sometimes melt due to high heat generated as a result of high resistance of filament. Thus, these factors leads to short life span of ordinary bulb.

81. **(d)** In case of motor car battery or automotive batteries a nominal 12-volt potential difference is provided by connecting six galvanic cells in series. Capacity of these batteries is expressed in ampere-hour. Electrolyte used is a solution of about 35% sulphuric acid and 65% water and electrodes used are plates of lead and separate plates of lead dioxide.

82. **(c)** A fluorescent lamp or fluorescent tube is a gas-discharge lamp that uses electricity to excite mercury vapour. The excited mercury atoms produce short-wave ultraviolet light that then causes a phosphor to fluoresce, producing visible light .In fluorescent tubes

the simplest ballast for alternating current use is an inductor (choke coil) placed in series, consisting of a winding on a laminated magnetic core. The inductance of this winding limits the flow of AC current on account of its large impedance. The only waste of energy is due to the hysteresis loss in the iron core, which is much less than the waste of energy in comparison to resistance which can also reduce the current if placed instead of the choking coil.

83. **(b)** Resistance (R) of a length l, resistivity ρ and area of cross-section A is given by
$$R = \rho \frac{l}{A}$$
For the two wires,
$$\frac{R_1}{R_2} = \frac{\rho_1}{\rho_2} \times \frac{l_1}{l_2} \times \frac{A_2}{A_1} = \frac{1}{2} \times \frac{1}{2} \times \frac{4}{1} = 1$$
$$\therefore \quad R_1 = R_2 = 10 \ \Omega$$
$$(\because \ \rho_1 : \rho_2 = l_1 : l_2 = 1 : 2 \text{ and } A_1 : A_2 = 1 : 4)$$

84. **(d)** An alternating current (a.c.) is one which is constantly changing direction. Alternating current have two cycles positive half cycle and negative half cycle. Mains electricity is an a.c. supply which is supplied to homes in India at 220 V AC at 50 Hz. Thus, in our houses the current in A.C. electricity line changes direction = 50 × 2 = 100 times per second.

85. **(b)** Human body has different resistances, when dry, resistance is 100,000 ohms. When wet because of sweat or water, resistance is only 1,000 ohms.

86. **(c)** A fluorescent lamp or fluorescent tube is a gas-discharge lamp that uses electricity to excite mercury vapour. The excited mercury atoms produce short-wave ultraviolet light that then causes a phosphor to fluoresce, producing visible light. 6500 K is usually printed on a used fluorescent tubelight.

87. **(c)** Graphene is a two-dimensional material and has good electrical conduction. It is one of the thinnest but strongest materials tested so far. It can be used for conducting electrodes required for touch screens, LCDs and organic LEDs.

88. **(a)** Earth's magnetic field diverts them torwards its poles.

89. **(a)** Gravity is the feeble force among the four.

E. Modern Physics

90. **(b)** **Frequency modulation :** It is a process in which the frequency of the carrier is varied in accordance with the instantaneous value of modulating voltage. In telecommunications and signal processing, frequency modulation (FM) conveys information over a carrier wave by varying its instantaneous frequency. FM is most commonly used for radio and television broadcasting.

91. **(a)** Solar energy, radiant light and heat from the sun, has been harnessed by humans since ancient times using a range of ever-evolving technologies. At present solar energy in our country is used for solar water heater. Solar lights that charge during the day and light up at night are a common sight along walkways.

92. (a) An astronomical unit (abbreviated as AU, au or a.u.) is a unit of length equal to about 149,597,870.7 kilometers or approximately the mean Earth-Sun distance. The astronomical constant whose value is one astronomical unit is referred to as unit distance and is given by the symbol A.

93. (c) In compact disc digital data is scanned by laser beam for the reproduction of recorded sound.

94. (d) Radio waves are a type of electromagnetic radiation with wavelengths in the electromagnetic spectrum longer than infrared light. Like all other electromagnetic waves, they travel at the speed of light. Artificially-generated radio waves are used for fixed and mobile radio communication, broadcasting, radar and other navigation systems, satellite communication, computer networks and innumerable other applications.

95. (a) A nuclear reactor is a device to initiate and control a sustained nuclear chain reaction. The most common use of nuclear reactors is for the generation of electrical power and for the power in some ships. In every fission reaction in which uranium nuclei splits up to give smaller nuclei three more neutrons are produced which further results into splitting of heavy uranium nuclei and more number of neutrons will be produced. Thus, statement, 1 and 2 are correct. In nuclear reactor all the neutrons produced can not take part in fission reaction, else reaction can turn out extremely violent. Thus, graphite rods are used as a control rods to slow down the speed of fast moving neutrons. Thus, statement 3 is also correct.

96. (b) The geostationary satellite is a satellite having a time-period of 24 hours. Using this time-period, the height of the satellite comes out to be approximately 35,800 km. FM broadcasting is a broadcast technology pioneered by Edwin Howard Armstrong that uses frequency modulation (FM) to provide high-fidelity sound over broadcast radio. FM transmission is quite immune to noise as compared to AM transmission. Noise is a form of amplitude variations in the transmitted signal due to atmosphere, industries, etc.

97. (c) Dolby B and C are the noise reduction circuits developed by Dolby laboratories. Dolby noise reduction has made it possible to protect the music from tape noise, and helped make cassette the most popular audio product ever devised.

98. (a) X-ray computed tomography (CT) is a medical imaging method employing tomography created by computer processing. This technique is used to generate a three-dimensional image of the inside of an object.

99. (a) The discovery of Higgs boson is important because it explains why sub atomic particles have mass. According to the scientists, Higgs boson is the only particle which explains how the basic building blocks of matter interact.

100. (a) When pure hydrogen is used as the fuel, the only by-products generated from the fuel cell are pure water and heat. Similar to a battery, a fuel cell with a supply of hydrogen and oxygen can be used to power devices that use electricity.

F. Space Physics

101. (c) A cryogenic rocket engine is a rocket engine that uses a cryogenic fuel or oxidiser, that is, its fuel or oxidizer (or both) are gases liquefied and stored at very low temperatures. Notably, these engines were one of the main factors of the ultimate success in reaching the Moon by the Saturn V rocket. Various cryogenic fuel-oxidizer combinations have been tried, but the combination of liquid hydrogen fuel and the liquid oxygen oxidizer is one of the most widely used.

102. (d) There is a presence of atmosphere at earth's surface which consists of thick and moving layers of air. The dust particles, particulates, smog, water vapour and smoke are also present in air. Stars twinkle when we see them from the Earth's surface because we are viewing them through thick layers of turbulent (moving) air in the Earth's atmosphere. As their light travels through the many layers of the Earth's atmosphere, the light of the star is bent (refracted) many times in random directions (light is bent when it hits a change in density –like a pocket of cold air or hot air). This random refraction results in the star as its twinkling but for a person in spaceship no such refractions are possible as there is vaccum in space. Thus, star will not twinkle.

Similarly, sky will appear blue to us due to Rayleigh scattering which is again due to presence of atmosphere on earth's surface. The shorter wavelength light is absorbed by the gas molecules of atmosphere. The absorbed blue light is then radiated in different directions. It gets scattered all around the sky. Some of this scattered blue light reaches you. Since, you see, the sky looks blue. Whereas no atmosphere is there in space thus, no absorbing and scattering is possible that's why for a person in spaceship sky appears black. Temperature outside the spaceship is higher in comparison to earth's surface because of being nearer to sun.

103. (c) The radiation emitted by sun exerts a radial presssure on the comet. So the tail of comet is always directed away from the sun.

104. (c) A black hole is a region of space from which nothing, not even light, can escape. It is the result of the deformation of spacetime caused by a very compact mass. The simplest black hole has mass but neither electric charge nor angular momentum. The mass of a black hole is finite, the reason why a black hole has infinite density is that it's mass is concentrated into a space of zero-volume. Thus, it has a very high density.

105. (c) Statement '2' and '3' is correct, but '1' is incorrect. Because INSAT–4A was launched on 22 December 2005 from French Guiana.

106. (a) Indian Remote Sensing (IRS) satellites are used in Assessment of crop productivity, Locating groundwater resources and Mineral exploration. This system was launched in 1979 and 1981. This system is used in agriculture, water resources, forestry and ecology, geology, marine fisheries and coastal management. It is the largest constellation of the remote sensing satellites.

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