Physics

1. Five cells each of emf E and internal resistance r send the same amount of current through an external resistance R whether the cells are connected in parallel or in series. Then, the ratio $\left(\frac{R}{r}\right)$ is

(a) 2 (b) $\frac{1}{2}$

(c) $\frac{1}{5}$ (d) 1

(e) 5

2. The power dissipated in the transmission cables carrying current I and voltage V is inversely proportional to

(a) V (b) V^2

(c) $\sqrt{V}$ (d) $\sqrt{I}$

(e) I

3. A rigid container with thermally insulated walls contains a gas and a coil of resistance 50 Ω, carrying a current of 1 A. The change in internal energy of the gas after 2 min will be

(a) 6 kJ (b) 10 kJ

(c) 3 kJ (d) 12 kJ

(e) 1.5 kJ

4. The magnitude of the magnetic field inside a long solenoid is increased by

(a) decreasing its radius

(b) decreasing the current through it

(c) increasing its area of cross-section

(d) introducing a medium of higher permeability

(e) decreasing the number of turns in it

5. A bar magnet of moment of inertia 9×10^{-5} kg m^2 placed in a vibration magnetometer and oscillating in a uniform magnetic field $16\pi^2 \times 10^{-5}$ T makes 20 oscillations in 15 s. The magnetic moment of the bar magnet is

(a) 3 A-m^2 (b) 2 A-m^2

(c) 5 A-m^2 (d) 6 A-m^2

(e) 4 A-m^2

6. Identify the correctly matched pair

Material		Example
(a) Diamagnetic	—	Gadolinium
(b) Soft ferromagnetic	—	Alnico
(c) Hard ferromagnetic	—	Copper
(d) Paramagnetic	—	Sodium
(e) Permanent magnet	—	Aluminium

7. If the radius of the dees of cyclotron is r, then the kinetic energy of a proton of mass m accelerated by the cyclotron at an oscillating frequency v is

(a) $4\pi^2m^2v^2r^2$ (b) $4\pi^2mv^2r^2$

(c) $2\pi^2mv^2r^2$ (d) $\pi^2mv^2r^2$

(e) $\pi^2m^2v^2r^2$

8. If a magnetic dipole of moment M situated in the direction of a magnetic field B is rotated by 180°, then the amount of work done is

(a) MB (b) $2MB$ (c) $\frac{MB}{\sqrt{2}}$ (d) zero

(e) $\sqrt{MB}$

9. The polarity of induced emf is given by
(a) Ampere's circuital law
(b) Biot-Savart's law
(c) Lenz's law
(d) Fleming's right hand rule
(e) Fleming's left hand rule

10. In an L-C-R series circuit, at resonance
(a) the current and voltage are in phase
(b) the impedance is maximum
(c) the current is minimum
(d) the quality factor is independent of R
(e) the current leads the voltage by $\frac{\pi}{2}$

11. A conducting ring of radius 1 m kept in a uniform magnetic field B of 0.01 T, rotates uniformly with an angular velocity 100 rad s^{-1} with its axis of rotation perpendicular to B. The maximum induced emf in it is
(a) 1.5π V (b) π V
(c) 2π V (d) 0.5π V
(e) 4π V

12. A step-down transformer increases the input current 4 A to 24 A at the secondary. If the number of turns in the primary coil is 330, the number of turns in the secondary coil is
(a) 60 (b) 50 (c) 65 (d) 45
(e) 55

13. In a plane electromagnetic wave, the electric field of amplitude 1 Vm^{-1} varies with time in free space. The average energy density of magnetic field is (in Jm^{-2})
(a) 8.86×10^{-12} (b) 4.43×10^{-12}
(c) 17.72×10^{-12} (d) 2.21×10^{-12}
(e) 1.11×10^{-12}

14. Which one of the following is the property of a monochromatic, plane electromagnetic wave in free space?
(a) Electric and magnetic fields have a phase difference of $\frac{\pi}{2}$
(b) The energy contribution of both electric and magnetic fields are equal
(c) The direction of propagation is in the direction of electric field E
(d) The pressure exerted by the wave is the product of energy density and the speed of the wave
(e) The speed of the wave is B/E

15. The apparent flattening of the sun at sunset and sunrise is due to
(a) refraction
(b) diffraction
(c) total internal reflection
(d) interference
(e) polarization

16. The polarising angle for a medium is found to be 60°. The critical angle of the medium is
(a) $\sin^{-1}\left(\frac{1}{2}\right)$ (b) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$
(c) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$ (d) $\sin^{-1}\left(\frac{1}{4}\right)$
(e) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$

17. Identify the mismatch in the following
(a) Myopia — Concave lens
(b) For rear view — Concave mirror
(c) Hypermetropia — Convex lens
(d) Astigmatism — Cylindrical lens
(e) Reflecting telescope — Convex mirror

18. In Young's double slit experiment, to increase the fringe width
(a) the wavelength of the source is increased
(b) the source is moved towards the slit
(c) the source is moved away from the slit
(d) the slit separation is increased
(e) the screen is moved towards the slit

19. Light of wavelength 5000 Å is incident normally on a slit of width 2.5×10^{-4} cm. The angular position of second minimum from the central maximum is
(a) $\sin^{-1}\left(\frac{1}{5}\right)$ (b) $\sin^{-1}\left(\frac{2}{5}\right)$
(c) $\left(\frac{\pi}{3}\right)$ (d) $\left(\frac{\pi}{6}\right)$
(e) $\left(\frac{\pi}{4}\right)$

20. An electron of mass m_e and a proton of mass m_p are accelerated through the same potential. Then, the ratio of their de-Broglie wavelengths is
(a) 1 (b) $\sqrt{\frac{m_e}{m_p}}$ (c) $\frac{m_e}{m_p}$ (d) $\frac{m_p}{m_e}$
(e) $\sqrt{\frac{m_p}{m_e}}$

21. The half-life of a radioactive substance is 20 min. The time taken between 50% decay and 87.5% decay of the substance will be

(a) 20 min (b) 30 min
(c) 40 min (d) 25 min
(e) 10 min

22. The ratio of the surface area of the nuclei $_{52}Te^{125}$ to that of $_{13}Al^{27}$ is

(a) $\frac{5}{3}$ (b) $\frac{125}{17}$
(c) $\frac{1}{4}$ (d) $\frac{25}{9}$
(e) $\frac{3}{5}$

23. If the frequency of incident light falling on a photosensitive metal is doubled, the kinetic energy of the emitted photoelectron is

(a) unchanged
(b) halved
(c) doubled
(d) more than twice its initial value
(e) reduced to $\frac{1}{4}$ th

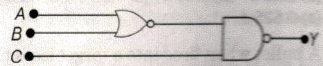
24. The significant result deduced from the Rutherford's scattering experiment is that

(a) whole of the positive charge is concentrated at the centre of atom
(b) there are neutrons inside the nucleus
(c) α-particles are helium nuclei
(d) electrons are embedded in the atom
(e) electrons are revolving around the nucleus

25. On an average, the number of neutrons and the energy of a neutron released per fission of a uranium atom are respectively

(a) 2.5 and 2 keV (b) 3 and 1 keV
(c) 2.5 and 2 MeV (d) 2 and 2 keV
(e) 1 and 2 MeV

26. The inputs A, B and C to be given in order to get an output $Y = 1$ from the following circuit are



(a) 0, 1, 0 (b) 1, 0, 0
(c) 1, 0, 1 (d) 1, 1, 0
(e) 0, 0, 1

27. The collector resistance and the input resistance of a CE amplifier are respectively 10 kΩ and 2 kΩ. If β of the transistor is 49, the voltage gain of the amplifier is

(a) 125 (b) 150
(c) 175 (d) 200
(e) 245

28. The light emitting diode (LED) is

(a) a heavily doped *p-n* junction with no external bias
(b) a heavily doped *p-n* junction with reverse bias
(c) a heavily doped *p-n* junction with forward bias
(d) a lightly doped *p-n* junction with no external bias
(e) a lightly doped *p-n* junction with reverse bias

29. A point-to-point communication mode is seen in

(a) satellite cable communication
(b) television transmission
(c) FM radio transmission
(d) AM radio transmission
(e) fax transmission

30. If the heights of transmitting and the receiving antennas are each equal to h, the maximum line-of-sight distance between them is (R is the radius of the earth)

(a) $\sqrt{2Rh}$ (b) $\sqrt{4Rh}$
(c) $\sqrt{6Rh}$ (d) $\sqrt{8Rh}$
(e) $\sqrt{Rh}$

31. The ionospheric layer acts as a reflector for the frequency range

(a) 1 kHz to 10 kHz
(b) 3 to 30 MHz
(c) 3 to 30 kHz
(d) 100 kHz to 1 MHz
(e) 3 GHz to 30 GHz

32. In a simple pendulum experiment, the maximum percentage error in the measurement of length is 2% and that in the observation of the time-period is 3%. Then, the maximum percentage error in determination of the acceleration due to gravity g is

(a) 5% (b) 6%
(c) 7% (d) 8%
(e) 10%

33. The pitch and the number of circular scale divisions in a screw gauge with least count 0.02 mm are respectively
(a) 1 mm and 100
(b) 0.5 mm and 50
(c) 1 mm and 50
(d) 0.5 mm and 100
(e) 1 mm and 200

34. A ball is dropped from the top of a tower of height 100 m and at the same time another ball is projected vertically upwards from ground with a velocity 25 ms^{-1}. Then, the distance from the top of the tower, at which the two balls meet is
(a) 68.4 m (b) 48.4 m (c) 18.4 m (d) 28.4 m
(e) 78.4 m

35. The ratio of distance traversed in successive intervals of time when a body falls freely under gravity from certain height is
(a) 1 : 2 : 3
(b) 1 : 5 : 9
(c) 1 : 3 : 5
(d) $\sqrt{1} : \sqrt{2} : \sqrt{3}$
(e) 1 : 4 : 9

36. A particle starting with certain initial velocity and uniform acceleration covers a distance of 12 m in first 3 s and a distance of 30 m in next 3 s. The initial velocity of the particle is
(a) 3 ms^{-1}
(b) 2.5 ms^{-1}
(c) 2 ms^{-1}
(d) 1.5 ms^{-1}
(e) 1 ms^{-1}

37. A ball of mass 10 g moving perpendicular to the plane of the wall strikes it and rebounds in the same line with the same velocity. If the impulse experienced by the wall is 0.54 Ns, the velocity of the ball is
(a) 27 ms^{-1}
(b) 3.7 ms^{-1}
(c) 54 ms^{-1}
(d) 37 ms^{-1}
(e) 5.4 ms^{-1}

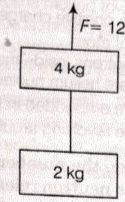
38. A particle has the position vector $\mathbf{r} = \hat{i} - 2\hat{j} + \hat{k}$ and the linear momentum $\mathbf{p} = 2\hat{i} - \hat{j} + \hat{k}$. Its angular momentum about the origin is
(a) $-\hat{i} + \hat{j} - 3\hat{k}$
(b) $-\hat{i} + \hat{j} + 3\hat{k}$
(c) $\hat{i} - \hat{j} + 3\hat{k}$
(d) $\hat{i} - \hat{j} - 5\hat{k}$
(e) $\hat{i} - \hat{j} + 5\hat{k}$

39. The vertical component of velocity of a projectile at its maximum height (u = velocity of projection, θ = angle of projection) is
(a) $u \sin\theta$ (b) $u \cos\theta$ (c) $\frac{u}{\sin\theta}$ (d) zero
(e) $\frac{u}{\cos\theta}$

40. The coordinates of a particle moving in x-y plane at any instant of time t are $x = 4t^2$; $y = 3t^2$. The speed of the particle at that instant is
(a) $10t$ (b) $5t$ (c) $3t$ (d) $2t$
(e) $\sqrt{13}\,t$

41. A cyclist bends while taking turn in order to
(a) reduce friction
(b) provide required centripetal force
(c) reduce apparent weight
(d) reduce speed
(e) sit comfortably

42. Two blocks of masses 2 kg and 4 kg are attached by an inextensible light string as shown in the figure. If a force of 120 N pulls the blocks vertically upward, the tension in the string is (take $g = 10\ ms^{-2}$)



(a) 20 N (b) 15 N (c) 35 N (d) 40 N
(e) 30 N

43. The total energy of a solid sphere of mass 300 g which rolls without slipping with a constant velocity of 5 ms^{-1} along a straight line is
(a) 5.25 J (b) 3.25 J (c) 0.25 J (d) 1.25 J
(e) 0.625 J

44. A bullet when fired into a target loses half of its velocity after penetrating 20 cm. Further distance of penetration before it comes to rest is
(a) 6.66 cm
(b) 3.33 cm
(c) 12.5 cm
(d) 10 cm
(e) 5 cm

45. In elastic collision
(a) both momentum and kinetic energy are conserved
(b) neither momentum nor kinetic energy is conserved
(c) only momentum is conserved
(d) only kinetic energy is conserved
(e) forces involved in the interaction and non-conservative

46. Two discs rotating about their respective axis of rotation with angular speed 2 rad s^{-1} and 5 rad s^{-1} are brought into contact such that their axes of rotation coincide. Now, the angular speed of the system becomes 4 rad s^{-1}. If the moment of inertia of the second disc is 1×10^{-3} kg m^2, then the moment of inertia of the first disc (in kg m^2) is
(a) 0.25×10^{-3} (b) 1.5×10^{-3}
(c) 1.25×10^{-3} (d) 0.75×10^{-3}
(e) 0.5×10^{-3}

47. A wheel is rotating at 1800 rpm about its own axis. When the power is switched off, it comes to rest in 2 min. Then, the angular retardation in rad s^{-1} is
(a) 2π (b) π (c) $\pi/2$ (d) $\pi/4$
(e) $\pi/6$

48. If the angular momentum of a particle of mass m rotating along a circular path of radius r with uniform speed is L, the centripetal force acting on the particle is
(a) $\frac{L^2}{mr^3}$ (b) $\frac{L^2}{mr}$ (c) $\frac{L}{mr^2}$ (d) $\frac{L^2m}{r}$
(e) $\frac{Lm}{r^2}$

49. Pick out the wrong statement from the following
(a) The SI unit of universal gravitational constant is Nm^2kg^{-2}
(b) The gravitational force is a conservative force
(c) The force of attraction due to a hollow spherical shell of uniform density on a point mass inside it is zero
(d) The centripetal acceleration of the satellite is equal to acceleration due to gravity
(e) Gravitational potential energy $= \frac{\text{gravitation potential}}{\text{mass of the body}}$

50. If a body of mass m has to be taken from the surface to the earth to a height $h = R$, then the amount of energy required is (R = radius of the earth)
(a) mgR (b) $\frac{mgR}{3}$
(c) $\frac{mgR}{2}$ (d) $\frac{mgR}{12}$
(e) $\frac{mgR}{9}$

51. The total energy of an artificial satellite of mass m revolving in a circular orbit around the earth with a speed v is
(a) $\frac{1}{2}mv^2$ (b) $\frac{1}{4}mv^2$
(c) $-\frac{1}{4}mv^2$ (d) $-mv^2$
(e) $-\frac{1}{2}mv^2$

52. Two soap bubbles each with radius r_1 and r_2 coalesce in vacuum under isothermal conditions to form a bigger bubble of radius R. Then, R is equal to
(a) $\sqrt{r_1^2 + r_2^2}$ (b) $\sqrt{r_1^2 - r_2^2}$
(c) $r_1 + r_2$ (d) $\frac{\sqrt{r_1^2 + r_2^2}}{2}$
(e) $2\sqrt{r_1^2 + r_2^2}$

53. The ratio of hydraulic stress to the corresponding strain is known as
(a) Compressibility (b) Bulk modulus
(c) Young's modulus (d) Rigidity modulus
(e) Expansion coefficient

54. A boy can reduce the pressure in his lungs to 750 mm of mercury. Using a straw he can drink water from a glass upto the maximum depth of (atmospheric pressure = 760 mm of mercury; density of mercury = 13.6 gcm^{-3})
(a) 13.6 cm (b) 9.8 cm
(c) 10 cm (d) 76 cm
(e) 1.36 cm

55. A spring stores 1J of energy for a compression of 1 mm. The additional work to be done to compress it further by 1 mm is
(a) 1 J (b) 2 J
(c) 3 J (d) 4 J
(e) 0.5 J

56. If m represents the mass of each molecule of a gas and T, its absolute temperature, then the root mean square velocity of the gaseous molecule is proportional to

(a) mT (b) $m^{1/2}T^{1/2}$
(c) $m^{-1/2}T$ (d) $m^{-1/2}T^{1/2}$
(e) $mT^{-1/2}$

57. A Carnot engine operating between temperatures T_1 and T_2 has efficiency 0.2. When T_2 is reduced by 50 K, its efficiency increases to 0.4. Then, T_1 and T_2 are respectively

(a) 200 K, 150 K (b) 250 K, 200 K
(c) 300 K, 250 K (d) 300 K, 200 K
(e) 300 K, 150 K

58. A molecule of a gas has six degrees of freedom. Then, the molar specific heat of the gas at constant volume is

(a) $\frac{R}{2}$ (b) R (c) $\frac{3R}{2}$ (d) $2R$
(e) $3R$

59. Total number of degrees of freedom of a rigid diatomic molecule is

(a) 3 (b) 6 (c) 5 (d) 2
(e) 7

60. If the differential equation for a simple harmonic motion is $\frac{d^2y}{dt^2} + 2y = 0$, the time period of the motion is

(a) $\pi\sqrt{2}$ s (b) $\frac{\sqrt{2}}{\pi}$ s (c) $\frac{\pi}{\sqrt{2}}$ s (d) 2π s
(e) $\frac{\sqrt{\pi}}{2}$ s

61. Identify the wrong statement from the following

(a) If the length of a spring is halved, the time period of each part becomes $\frac{1}{\sqrt{2}}$ times the original
(b) The effective spring constant K of springs in parallel is given by $\frac{1}{K} = \frac{1}{K_1} + \frac{1}{K_2} + \ldots$
(c) The time period of a stiffer spring is less than that of a soft spring
(d) The spring constant is inversely proportional to the spring length
(e) The unit of spring constant is Nm^{-1}

62. The total energy of the particle executing simple harmonic motion of amplitude A is 100 J. At a distance of 0.707 A from the mean position, its kinetic energy is

(a) 25 J (b) 50 J
(c) 100 J (d) 12.5 J
(e) 70 J

63. Two travelling waves, $y_1 = A\sin[k(x + ct)]$ and $y_2 = A\sin[k(x - ct)]$ are superposed on a string. The distance between adjacent antinodes is

(a) $\frac{ct}{\pi}$ (b) $\frac{ct}{2\pi}$
(c) $\frac{\pi}{2k}$ (d) $\frac{k}{\pi}$
(e) $\frac{\pi}{k}$

64. If a stretched wire is vibrating in the second overtone, then the number of nodes and antinodes between the ends of the string are respectively

(a) 2 and 2 (b) 1 and 2
(c) 4 and 3 (d) 2 and 3
(e) 3 and 4

65. Pick out the correct statement in the following with reference to stationary wave pattern

(a) In a tube closed at one end, all the harmonics are present
(b) In a tube open at one end, only even harmonics are present
(c) The distance between successive nodes is equal to the wavelength
(d) In a stretched string, the first overtone is the same as the second harmonic
(e) Reflection of a wave from a rigid wall changes the phase by 45°

66. A plane square sheet of charge of side 0.5 m has uniform surface charge density. An electron at 1 cm from the centre of the sheet experiences a force of 1.6×10^{-12} N directed away from the sheet. The total charge on the plane square sheet is
($\varepsilon_0 = 8.854 \times 10^{-12}\ C^2m^{-2}N^{-1}$)

(a) 16.25 μC (b) −22.15 μC
(c) −44.27 μC (d) 144.27 μC

67. The energy stored in a capacitor of capacitance C having a charge Q under a potential V is

(a) $\frac{1}{2}Q^2V$ (b) $\frac{1}{2}C^2V$

(c) $\frac{1}{2}\frac{Q^2}{V}$ (d) $\frac{1}{2}QV$

(e) $\frac{1}{2}CV$

68. The electrostatic force between two point charges is directly proportional to the

(a) sum of the charges
(b) distance between the charges
(c) permittivity of the medium
(d) square of the distance between the charges
(e) product of the charges

69. The time period of revolution of a charge q_1 and of mass m moving in a circular path of radius r due to Coulomb force of attraction with another charge q_2 at its centre is

(a) $\sqrt{\frac{16\pi\varepsilon_0 mr^3}{q_1q_2}}$ (b) $\sqrt{\frac{8\pi^2\varepsilon_0 mr^3}{q_1q_2}}$

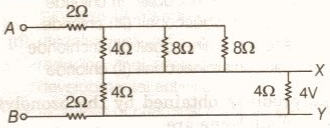
(c) $\sqrt{\frac{\varepsilon_0 mr^3}{16q_1q_2}}$ (d) $\sqrt{\frac{16\pi^3\varepsilon_0 mr^3}{q_1q_2}}$

(e) $\sqrt{\frac{\pi^2\varepsilon_0 mr^3}{8q_1q_2}}$

70. A point charge of 2 C experiences a constant force of 1000 N when moved between two points separated by a distance of 2 cm in a uniform electric field. The potential difference between the two points is

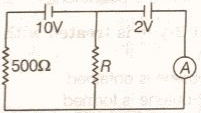
(a) 12 V (b) 8 V (c) 10 V (d) 16 V
(e) 5 V

71. In the network shown below, if potential across XY is 4 V, then the input potential across AB is



(a) 16 V (b) 20 V (c) 8 V (d) 12 V
(e) 24 V

72. If the ammeter A shows a zero reading in the circuit shown below, the value of resistance R is



(a) 500 Ω (b) 125 Ω
(c) 100 Ω (d) 41.5 Ω
(e) 4 Ω