1. Consider Fraunhofer diffraction pattern obtained with a single slit at normal incidence. At the angular position of first diffraction minimum, the phase difference between the wavelets from the opposite edges of the slit is

(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{2}$

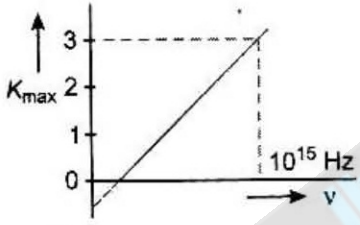
(c) π (d) 2π

2. Which of the following lines of the H-atom spectrum belongs to the Balmer series?

(a) 1025 Å (b) 1218 Å

(c) 4861 Å (d) 18751 Å

3. Figure represents a graph of kinetic energy of most energetic photoelectrons, K_{max} (in eV), and frequency (ν) for a metal used as cathode in photoelectric experiment. The threshold frequency of light for the photoelectric emission from the metal is



(a) 1×10^{14} Hz (b) 1.5×10^{14} Hz

(c) 2.1×10^{14} Hz (d) 2.7×10^{14} Hz

4. Using the following data:

Mass of hydrogen atom = 1.00783 u

Mass of neutron = 1.00867 u

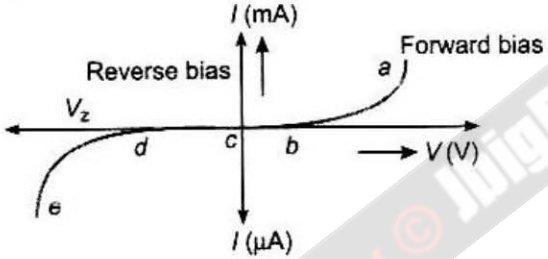
Mass of nitrogen atom ($_7N^{14}$) = 14.00307 u

The calculated value of the binding energy of the nucleus of the nitrogen atom ($_7N^{14}$) is close to

(a) 56 MeV (b) 98 MeV

(c) 104 MeV (d) 112 MeV

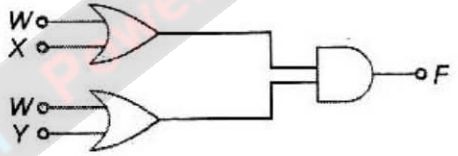
5. The graph given below represents the *I-V* characteristics of a zener diode. Which part of the characteristics curve is most relevant for its operation as a voltage regulator?



(a) *ab* (b) *bc*

(c) *cd* (d) *de*

6. The diagram of a logic circuit is given below.



The output *F* of the circuit is given by

(a) $W \cdot (X + Y)$ (b) $W \cdot (X \cdot Y)$

(c) $W + (X \cdot Y)$ (d) $W + (X + Y)$

7. A quantity *X* is given by $\varepsilon_0 L \frac{\Delta V}{\Delta t}$, where ε_0 is the permittivity of free space, *L* is a length, ΔV is a potential difference and Δt is a time interval. The dimensional formula for *X* is the same as that of

(a) electrical resistance

(b) electric charge

(c) electric voltage

(d) electric current

8. Displacement (x) of a particle is related to time (t) as

$$x = at + bt^2 - ct^3$$

where *a*, *b* and *c* are constants of the motion. The velocity of the particle when its acceleration is zero is given by

(a) $a+\frac{b^2}{c}$ (b) $a+\frac{b^2}{2c}$

(c) $a+\frac{b^2}{3c}$ (d) $a+\frac{b^2}{4c}$

9. A body is thrown vertically up with a velocity u. It passes three points A, B and C in its upward journey with velocities $\frac{u}{2}$, $\frac{u}{3}$ and $\frac{u}{4}$ respectively. The ratio of the separations between points A and B and between B and C, *ie*, $\frac{AB}{BC}$ is

(a) 1 (b) 2

(c) $\frac{10}{7}$ (d) $\frac{20}{7}$

10. A body moves from a position

$\vec{\mathbf{r}}_1 = (2\hat{\mathbf{i}} - 3\hat{\mathbf{j}} - 4\hat{\mathbf{k}})$ m to a position

$\vec{\mathbf{r}}_2 = (3\hat{\mathbf{i}} - 4\hat{\mathbf{j}} + 5\hat{\mathbf{k}})$ m under the influence of a constant force $\vec{\mathbf{F}} = (4\hat{\mathbf{i}} + \hat{\mathbf{j}} + 6\hat{\mathbf{k}})$ N. The work done by the force is

(a) 57 J (b) 58 J

(c) 59 J (d) 60 J

11. A particle moves in the x-y plane under the influence of a force such that its linear momentum is

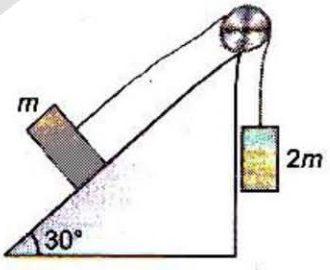
$$\vec{\mathbf{p}}(t) = A[\hat{\mathbf{i}} \cos(kt) - \hat{\mathbf{j}} \sin(kt)]$$

where A and k are constants. The angle between the force and momentum is

(a) 0° (b) 30°

(c) 45° (d) 90°

12. Two blocks of masses m and $2m$ are connected by a light string passing over a frictionless pulley. As shown in the figure, the mass m is placed on a smooth inclined plane of inclination 30° and $2m$ hangs vertically. If the system is released, the blocks move with an acceleration equal to



(a) $\frac{g}{4}$ (b) $\frac{g}{3}$

(c) $\frac{g}{2}$ (d) g

13. Identify the wrong statement.

(a) The electrical potential energy of a system of two protons shall increase if the separation between the two is decreased.

(b) The electrical potential energy of a proton-electron system will increase if the separation between the two is decreased.

(c) The electrical potential energy of a proton-electron system will will increase if the separation between the two is increased.

(d) The electrical potential energy of system of two electrons shall increase if the separation between the two is decreased.

14. A small roller coaster starts at point A with a speed u on a curved track as shown in the figure.

The friction between the roller coaster and the track is negligible and it always remains in contact with the track. The speed of roller coaster at point D on the track will be

(a) $(u^2 + gh)^{1/2}$ (b) $(u^2 + 2gh)^{1/2}$

(c) $(u^2 + 4gh)^{1/2}$ (d) u

15. A particle is moving in the x-y plane with a constant velocity along a line parallel to the x-axis away from the origin. The magnitude of its angular momentum about the origin

(a) is zero (b) remains constant

(c) goes on increasing (d) goes on decreasing

16. Two particles A and B, initially at rest, move towards each other under a mutual force of attraction. At the instant when the speed of A is v and that of B is $2v$, the speed of the centre of mass of the system is

(a) zero (b) v

(c) $1.5v$ (d) $3v$

17. A geostationary satellite is orbiting the earth at a height of $6R$ above the surface of the earth; R being the radius of the earth. What will be the time period of another satellite at a height $2.5R$ from the surface of the earth?

(a) $6\sqrt{2}$ h (b) $6\sqrt{2.5}$ h

(c) $6\sqrt{3}$ h (d) 12 h

18. $\vec{F}_{pe}$ represents electrical force on proton due to electron and $\vec{F}_{ep}$ on electron due to proton in a hydrogen atom. Similarly, $\vec{F}_{pe}$ represents the gravitational force on proton due to electron and $\vec{F}_{ep}$ the corresponding force on electron due to proton. Which of the following is not true?

(a) $\vec{F}_{pe} + \vec{F}_{ep} = 0$

(b) $\vec{F}'_{pe} + \vec{F}'_{ep} = 0$

(c) $\vec{F}_{pe} + \vec{F}'_{pe} + \vec{F}_{ep} + \vec{F}'_{ep} = 0$

(d) $\vec{F}_{pe} + \vec{F}'_{pe} = 0$

19. Two uniform brass rods A and B of length l and $2l$ and radii $2r$ and r respectively are heated to the same temperature. The ratio of the increase in the volume of A to that of B is

(a) 1 : 1 (b) 1 : 2
(c) 2 : 1 (d) 1 : 4

20. Water flows steadily through a horizontal pipe of a variable cross-section. If the pressure of water is p at a point where the velocity of flow is v, what is the pressure at another point where the velocity of flow is $2v$, ρ being the density of water?

(a) $p + 2\rho v^2$ (b) $p - 2\rho v^2$
(c) $p + \frac{3}{2}\rho v^2$ (d) $p - \frac{3}{2}\rho v^2$

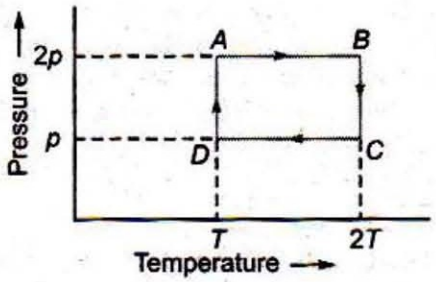
21. A vessel contains oil (density 0.8 g cm^{-3}) over mercury (density 13.6 g cm^{-3}). A homogenous sphere floats with half volume immersed in mercury and the other half in oil. The density of the material of the sphere in g cm^{-3} is

(a) 12.8 (b) 7.2
(c) 6.4 (d) 3.3

22. A steel wire of cross-sectional area 3×10^{-6} m^2 can withstand a maximum strain of 10^{-3}. Young's modulus of steel is 2×10^{11} Nm^{-2}. The maximum mass the wire can hold is (Take $g = 10$ ms^{-2})

(a) 40 kg (b) 60 kg
(c) 80 kg (d) 100 kg

23. One mole of an ideal gas having initial volume V, pressure $2p$ and temperature T undergoes a cyclic process $ABCDA'$ as shown below.



The net work done in the complete cycle is

(a) zero (b) $\frac{1}{2}RT \ln 2$
(c) $RT \ln 2$ (d) $\frac{3}{2}RT \ln 2$

24. When two moles of oxygen is heated from 0°C–10°C at constant volume, its internal energy changes by 420 J. What is the molar specific heat of oxygen at constant volume?

(a) 5.75 JK^{-1} mol^{-1} (b) 10.5 JK^{-1} mol^{-1}
(c) 21 JK^{-1} mol^{-1} (d) 42 JK^{-1} mol^{-1}

25. A vessel contains 32 g of O_2 at a temperature T. The pressure of the gas is p. An identical vessel containing 4 g of H_2 at a temperature $2T$ has a pressure of

(a) $8p$ (b) $4p$
(c) p (d) $\frac{p}{8}$

26. A tuning fork produces 4 beats s^{-1} when sounded with a sonometer wire of vibrating length 48 cm. It produces 4 beats s^{-1} also when the vibrating length is 50 cm. What is the frequency of the tuning fork?

(a) 196 Hz (b) 284 Hz
(c) 375 Hz (d) 460 Hz

27. The displacement y of a particle is given by $y = 4\cos^2\left(\frac{t}{2}\right)\sin(1000t)$. This expression may be considered to be a result of the superposition of how many simple harmonic motions?

(a) 2 (b) 3
(c) 4 (d) 5

28. A progressive wave in a medium is represented by the equation $y = 0.1\sin\left(10\pi t - \frac{5}{11}\pi x\right)$ where y and x are in cm and t in second. The wavelength and velocity of the wave is

(a) $\frac{5}{11}$ m, 31.4 cm s^{-1} (b) 4.4 m, 22 cm s^{-1}
(c) 2.2 m, 11 cm s^{-1} (d) $\frac{11}{5}$ m, 22 cm s^{-1}

29. Identify the wrong statement.

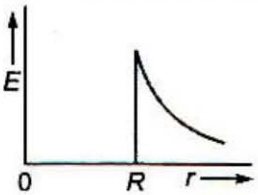
(a) In an electric field two equipotential surfaces can never intersect.

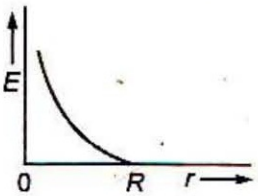
(b) A charged particle free to move in an electric field shall always move in the direction of $\vec{E}$.

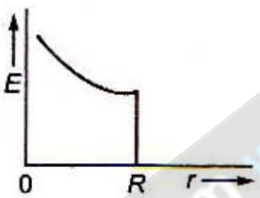
(c) Electric field at the surface of a charged conductor is always normal to the surface.

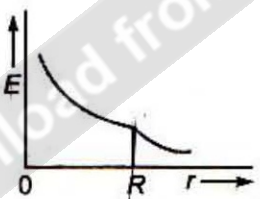
(d) The electric potential decrease along a line of force in an electric field.

30. A metallic spherical shell of radius R has a charge $-Q$ on it. A point charge $+Q$ is placed at the centre of the shell. Which of the graphs shown below may correctly represent the variation of the electric field E with distance r from the centre of the shell?

(a) 

(b) 

(c) 

(d) 

31. Two positive point charges of 12 μC and 5 μC, are placed 10 cm apart in air. The work needed to bring them 4 cm closer is

(a) 2.4 J (b) 3.6 J

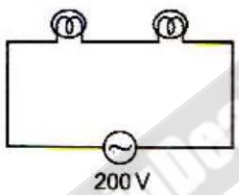
(c) 4.8 J (d) 6.0 J

32. Two parallel plate capacitors of capacitances C and $2C$ are connected in parallel and charged to a potential difference V_0. The battery is then disconnected and the region between the plates of the capacitor C is completely filled with a material of dielectric constant 2. The potential difference across the capacitors now becomes

(a) $\frac{F_0}{4}$ (b) $\frac{V_0}{2}$

(c) $\frac{3V_0}{4}$ (d) V_0

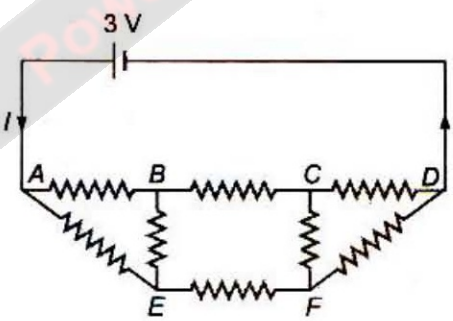
33. Two bulbs marked 200 V–100 W and 200 V–200 W are joined in series and connected to a power supply of 200 V. The total power consumed by the two will be near to



(a) 35 W (b) 66 W

(c) 100 W (d) 300 W

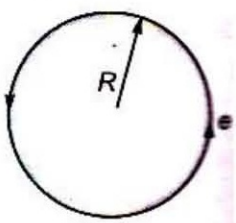
34. Figure shows a network of eight resistors, each equal to 2 Ω, connected to a 3 V battery of negligible internal resistance. The current I in the circuit is



(a) 0.25 A (b) 0.50 A

(c) 0.75 A (d) 1.0 A

35. An electron is moving in an orbit of radius R with a time period T as shown in the figure. The magnetic moment produced may be given by



$|\vec{A}| = \pi R^2$

(a) $\vec{M} = \frac{2\pi |e| \vec{A}}{T}$

(b) $\vec{M} = -\frac{2\pi |e| \vec{A}}{T}$

(c) $\vec{M} = \frac{|e| \vec{A}}{T}$

(d) $\vec{M} = -\frac{|e| \vec{A}}{T}$

$|e|$ represents the magnitude of the electron charge.

36. A horizontal straight wire 10 m long extending from east to west is falling with a speed of 5.0 ms^{-1}, at right angles to the horizontal component of the earth's magnetic field of strength 0.30×10^{-4} Wb m^{-2}. The instantaneous value of the induced potential gradient in the wire, from west to east, is

(a) $+1.5 \times 10^{-3}$ Vm^{-1} (b) -1.5×10^{-3} Vm^{-1}

(c) $+1.5 \times 10^{-4}$ Vm^{-1} (d) -1.5×10^{-4} Vm^{-1}

37. A uniformly wound solenoid coil of self-inductance 1.8×10^{-4} H and resistance 6 Ω is broken up into two identical coils. These identical coils are then connected in parallel across a 12 V battery of negligible resistance. The time constant for the current in the circuit is

(a) 0.1×10^{-4} s (b) 0.2×10^{-4} s

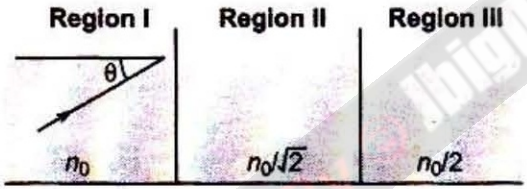
(c) 0.3×10^{-4} s (d) 0.4×10^{-4} s

38. An *LC* circuit contains a 20 mH inductor and a 50 μF capacitor with an initial charge of 10 mC. The resistance of the circuit is negligible. Let the instant the circuit is closed be $t = 0$. At what time is the energy stored completely magnetic?

(a) $t = 0$ (b) $t = 1.54$ ms

(c) $t = 3.14$ ms (d) $t = 6.28$ ms

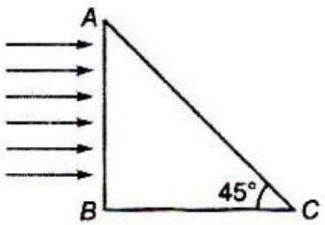
39. A beam of light is travelling from region II to region III (see the figure). The refractive index in region I, II and III are n_0, $\frac{n_0}{\sqrt{2}}$ and $\frac{n_0}{2}$ respectively. The angle of incidence θ for which the beam just misses entering region III is



(a) 30° (b) 45°

(c) 60° (d) $\sin^{-1}(\sqrt{2})$

40. A beam of light consisting of red, green and blue colours is incident on a right-angled prism *ABC*. The refractive indices of the material of the prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. The colour/colours transmitted through the face *AC* of the prism will be



(a) red only (b) red and green

(c) all the three (d) None of these

Answer – Key

1. d	2. c	3. d	4. c	5. d	6. c	7. d	8. c	9. d	10. a
11. d	12. c	13. c	14. d	15. b	16. a	17. a	18. d	19. c	20. d
21. b	22. b	23. c	24. c	25. b	26. a	27. b	28. b	29. b	30. b
31. b	32. c	33. b	34. d	35. b	36. a	37. c	38. b	39. a	40. a