Consortium of Medical Engineering and Dental Colleges of Karnataka

(COMEDK-2010)

1. Find the dimensions of electric permittivity.
   (a) $[A^2M^{-1}L^{-3}T^4]$ (b) $[A^2M^{-1}L^{-3}T^0]$
   (c) $[AM^{-1}L^{-3}T^4]$ (d) $[A^2M^0L^{-3}T^4]$

2. A ship of mass 3×10^7 kg, initially at rest, is pulled by a force of 5×10^4 N through a distance of 3 m. Assuming that the resistance due to water is negligible, the speed of the ship is
   (a) 1.5 m/s (b) 60 m/s
   (c) 0.1 m/s (d) 5 m/s

3. If the external forces acting on a system have zero resultant, the centre of mass
   (a) may move but not accelerate
   (b) may accelerate
   (c) must not move
   (d) None of the above

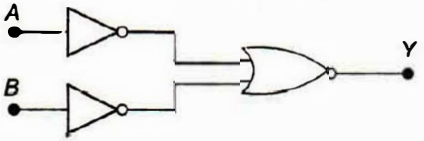
4. An object is placed on the surface of a smooth inclined plane of inclination θ. It takes time t to reach the bottom. If the same object is allowed to slide down a rough inclined plane of inclination θ, it takes time nt to reach the bottom, where n is a number greater than 1. The coefficient of friction μ is given by
   (a) $\mu = \tan\theta\left(1-\frac{1}{n^2}\right)$
   (b) $\mu = \cos\theta\left(1-\frac{1}{n^2}\right)$
   (c) $\mu = \tan\theta\sqrt{1-\frac{1}{\sqrt{n^2}}}$
   (d) $\mu = \cot\theta\sqrt{1-\frac{1}{n^2}}$

5. A 500 kg horse pulls a cart of mass 1500 kg along a level road with an acceleration of 1 m/s^2. If the coefficient of sliding friction is 0.2, then the horizontal force exerted by the earth on the horse is
   (a) 300 kg-wt (b) 400 kg-wt
   (c) 500 kg-wt (d) 600 kg-wt

6. A spring is held compressed so that its stored energy is 2.4 J. Its ends are in contact with masses 1 g and 48 g placed on a frictionless table. When the spring is released, the heavier mass will acquire a speed of
   (a) $\frac{2.4}{49}$ ms^{-1} (b) $\frac{2.4\times48}{49}$ ms^{-1}
   (c) $\frac{10^3}{7}$ cms^{-1} (d) $\frac{10^6}{7}$ cms^{-1}

7. Two simple pendulums first (A) of bob mass M_1 and length L_1, second (B) of bob mass M_2 and length L_2. $M_1 = M_2$ and $L_1 = 2L_2$. If the vibrational energy of both is same. Then which of the following is correct?
   (a) Amplitude of B is greater than that of A
   (b) Amplitude of B is smaller than that of A
   (c) Amplitude will be same
   (d) None of the above

8. Which logic gate is represented by the following combination of logic gates?



   (a) OR (b) NAND
   (c) AND (d) NOR

9. A body of mass m is situated on the earth in the gravitational field of sun. For the body to escape from the gravitation pull of the solar system the body must be imparted an escape velocity of (assume earth to be stationary)

(a) 11.2 km/s (b) 22.4 km/s
(c) 33.6 km/s (d) 42 km/s

10. Find the lifting force of a 4 kg cork life belt in sea water, if the densitites of cork and sea water are 0.2×10^3 kg/m^3 and 1.03×10^3 kg/m^3 respectively.

(a) 163 N (b) 273 N
(c) 119 N (d) 298 N

11. Nitrogen (N_2) is in equilibrium state at $T = 421$ K. The value of most probable speed, v_{mp} is

(a) 400 m/s (b) 421 m/s
(c) 500 m/s (d) 600 m/s

12. The temperature at which the velocity of oxygen will be half that of hydrogen at NTP is

(a) 1092°C (b) 1492°C
(c) 273 K (d) 819°C

13. Two sound waves, each of amplitude A and frequency ω, superpose at a point with phase difference of $\frac{\pi}{2}$. The amplitude and frequency of the resultant wave are respectively

(a) $\frac{A}{\sqrt{2}}, \frac{\omega}{2}$ (b) $\frac{A}{\sqrt{2}}, \omega$
(c) $\sqrt{2}A, \frac{\omega}{2}$ (d) $\sqrt{2}\,A, \omega$

14. A source emits electromagnetic waves of wavelength 3 m. One beam reaches the observer directly and other after reflection from a water surface, travelling 1.5 m extra distance and with intensity reduced to (1/4) as compared to intensity due to direct beam alone. The resultant intensity will be

(a) (1/4) fold (b) (3/4) fold
(c) (5/4) fold (d) (9/4) fold

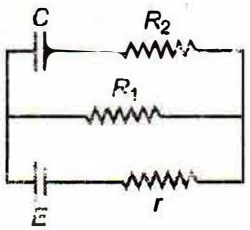
15. A square of side 3 cm is located at a distance 25 cm from a concave mirror of focal length 10 cm. The centre of square is at the axis of the mirror and the plane is normal to axis of mirror. The area enclosed by the image of the square is

(a) 4 cm^2 (b) 6 cm^2
(c) 16 cm^2 (d) 36 cm^2

16. A charge q is placed at the centre of the line joining two equal charges Q. The system of the three charges will be in equilibrium if q is equal to

(a) $-\frac{Q}{2}$ (b) $-\frac{Q}{4}$
(c) $+\frac{Q}{4}$ (d) $+\frac{Q}{2}$

17. The numerical value of charge on either plate of capacitor C shown in figure



(a) CE (b) $\frac{CER_1}{R_1 + r}$
(c) $\frac{CER_2}{R_2 + r}$ (d) $\frac{CER_1}{R_2 + r}$

18. A proton enters a magnetic field of flux density 1.5 Wb/m^2 with a speed of 2×10^7 m/s at angle of 30° with the field. The force on a proton will be

(a) 0.24×10^{-12} N (b) 2.4×10^{-12} N
(c) 24×10^{-12} N (d) 0.024×10^{-12} N

19. Two long straight wires are set parallel to each other at separation r and each carries a current i in the same direction. The strength of the magnetic field at any point midway between the two wires is

(a) $\frac{\mu_0 i}{\pi r}$ (b) $\frac{2\mu_0 i}{\pi r}$
(c) $\frac{\mu_0 i}{2\pi r}$ (d) zero

20. The work done in turning a magnet of magnetic moment M by an angle of 90° from the meridian is n times the corresponding work done to turn it through an angle of 60°

(a) $n = \frac{1}{2}$ (b) $n = 2$
(c) $n = \frac{1}{4}$ (d) $n = 1$

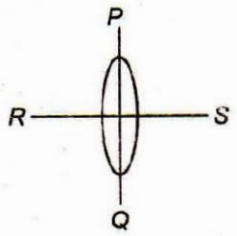
21. An inductive coil has a resistance of 100 Ω. When an AC signal of frequency 1000 Hz is applied to the coil, the voltage leads the current by 45°. The inductance of the coil is

(a) $\frac{1}{10\pi}$ (b) $\frac{1}{20\pi}$
(c) $\frac{1}{40\pi}$ (d) $\frac{1}{60\pi}$

22. An inductor of 1 H is connected across a 220 V, 50 Hz supply. The peak value of the current is approximately

(a) 0.5 A (b) 0.7 A
(c) 1 A (d) 1.4 A

23. The figure shows an equiconvex lens of focal length f. If the lens is cut along PQ, the focal length of each half will be



(a) $\frac{f}{2}$ (b) f
(c) $2f$ (d) $4f$

24. Light of two different frequencies whose photons have energies 1 eV and 2.5 eV successively illuminate a metal of work function 0.5 eV. The ratio of the maximum speeds of the emitted electrons will be
(a) 1 : 5 (b) 1 : 4
(c) 1 : 2 (d) 1 : 1

25. An electron jumps from the first excited state to the ground state of hydrogen atom. What will be the percentage change in the speed of electron?
(a) 25% (b) 50%
(c) 100% (d) 200%

26. The mutual inductance of a pair of coils, each of N turns, is M henry. If a current of i ampere in one of the coils is brought to zero in t second, the emf induced per turn in the other coil, in volt will be
(a) $\frac{Mi}{t}$ (b) $\frac{NMi}{t}$
(c) $\frac{MN}{it}$ (d) $\frac{Mi}{Nt}$

27. A body falls from rest. In the last second of its fall it covers half of the total distance. If g is 9.8 m/s^2, then the total time of its fall is (in second)
(a) 2 (b) $2+\sqrt{2}$
(c) $2-\sqrt{2}$ (d) $2\pm\sqrt{2}$

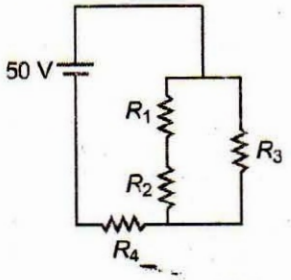
28. A force $\vec{\mathbf{F}} = a\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 6\hat{\mathbf{k}}$ is acting at a point $\vec{\mathbf{r}} = 2\hat{\mathbf{i}} - 6\hat{\mathbf{j}} - 12\hat{\mathbf{k}}$. The value of a for which angular momentum is conserved is
(a) zero (b) 1
(c) -1 (d) 2

29. A wooden block is floating in a liquid 50% of its volume inside the liquid when the vessel is stationary. Percentage of volume immersed when the vessel moves upwards with an acceleration $a = g/3$ is
(a) 30% (b) 50%
(c) 60% (d) 67%

30. Two resistors 400 Ω and 800 Ω are connected in series with a 6 V battery. The potential difference measured by voltmeter of 10 kΩ across 400 Ω resistor is
(a) 2 V (b) 1.95 V
(c) 3.8 V (d) 4 V

31. An astronomical telescope in normal adjustment receives light from a distant source S the tube length is now decreased slightly, then
(a) no image will be formed
(b) a virtual image of S will be formed at a finite distance
(c) a large, real image of S will be formed behind the eye-piece, far away from it
(d) a small, real image of S will be formed behind the eye-piece close to it

32. The potential difference in volt across the resistance R_3 in the circuit shown in figure, is ($R_1 = 15\,\Omega$, $R_2 = 15\,\Omega$, $R_3 = 30\,\Omega$, $R_4 = 35\,\Omega$)



(a) 5 (b) 7.5
(c) 15 (d) 12.5

33. The ratio of molecular masses of two radioactive substances is 3/2 and the ratio of their decay constants is 4/3. Then, the ratio of their initial activities per mole will be
(a) 2 (b) 4/3
(c) 8/9 (d) 9/8

34. The resultant of two forces P and Q is of magnitude P. If P be doubled, the resultant will be inclined to Q at an angle
(a) 0° (b) 30°
(c) 60° (d) 90°

35. A person is at a distance x from a bus when the bus begins to move with a constant acceleration a. What is the minimum velocity

with which the person should run towards the bus so as to catch it?

(a) $2ax$ (b) $\sqrt{2ax}$
(c) ax (d) $\sqrt{ax}$

36. A car is travelling with linear velocity v on a circular road of radius r. If it is increasing its speed at the rate of a m/s^2, then the resultant acceleration will be

(a) $\left(\frac{v^2}{r} + a\right)$ (b) $\left(\frac{v^2}{r^2} + a\right)^{1/2}$
(c) $\left(\frac{v^4}{r^2} + a^2\right)^{1/2}$ (d) $\left(\frac{v^2}{r^2} - a^2\right)^{1/2}$

37. A body of mass 10 kg at rest explodes into two pieces of masses 7 kg and 3 kg. If the total increase in kinetic energy due to explosion is 1680 J, the magnitude of their relative velocity in m/s, after explosion is

(a) 40 (b) 50
(c) 70 (d) 80

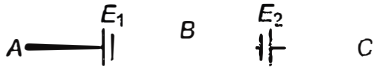
38. The moment of inertia of a body about a given axis is 1.2 kg m^2. Initially the body is at rest. In order to produce a rotational kinetic energy of 1500 J, an angular acceleration of 25 rad/s^2 must be applied about that axis for a duration of

(a) 4 s (b) 2 s
(c) 8 s (d) 10 s

39. Steel and aluminium wires have equal resistances and masses. Which of the wires is longer and how many times? (Given, densities of steel and aluminium are 7.8×10^3 kg m^{-3} and 2.7×10^3 kg m^{-3} and their resistivities are 0.15 μΩ-m and 0.028 μΩ-m respecitvely)

(a) The aluminium wire is 3.9 times longer
(b) The aluminium wire is 1.3 times longer
(c) The aluminium wire is 2.6 times longer
(d) The steel wire is 3.9 times longer

40. Two cells of emfs E_1 and E_2 ($E_1 > E_2$) are connected as shown in figure.



When a potentiometer is connected between A and B, the balancing length of the potentiometer wire is 300 cm. On connecting the same potentiometer between A and C, the balancing length is 100 cm. The ratio $\frac{E_1}{E_2}$ is

(a) 3 :1 (b) 1 : 3
(c) 2 : 3 (d) 3 : 2

41. In hydrogen atom the electron is making 6.6×10^{15} rev/s around the nucleus of radius 0.53 Å. The magnetic field produced at the centre of the orbit is nearly

(a) 0.12 Wb/m^2 (b) 1.2 Wb/m^2
(c) 12 Wb/m^2 (d) 120 Wb/m^2

42. An AC source is 120 V-60 Hz. The value of voltage after $\frac{1}{720}$ s from start will be

(a) 20.2 V (b) 42.4 V
(c) 84.8 V (d) 106.8 V

43. The energy difference between the first two levels of hydrogen atom is 10.2 eV. For another element of atomic number 10 and mass number 20, this will be

(a) 1020 eV (b) 2040 eV
(c) 0.51 eV (d) 0.102 eV

44. The following equation represents induced transmutation

$$_4Be^9 + {}_2He^4 \longrightarrow {}_6C^{12} + X$$

In this equation, X represents

(a) one β^- particle (b) α-particle
(c) a positron (d) a neutron

45. The masses of neutron and proton are 1.0087 and 1.0073 amu respectively. If the neutrons and protons combine to form helium nucleus of mass 4.0015 amu the binding energy of the helium nucleus will be

(a) 28.4 MeV (b) 20.8 MeV
(c) 27.3 MeV (d) 14.2 MeV

46. The activity of a radioactive sample is measured as 9750 count/min at $t = 0$ and 975 count/min at $t = 5$ min. The decay constant is nearly

(a) 0.922 min^{-1}
(b) 0.691 min^{-1}
(c) 0.461 min^{-1}
(d) 0.230 min^{-1}

47. Light of wavelength λ, strikes a photoelectric surface and electrons are ejected with an energy E. If E is to be increased to exactly twice its original value, the wavelength changes to λ′, where

(a) λ′ is less than $\frac{\lambda}{2}$

(b) λ′ is greater than $\frac{\lambda}{2}$

(c) λ' is greater than $\frac{\lambda}{2}$ but less than λ

(d) λ' is exactly equal to $\frac{\lambda}{2}$

48. Three point masses, each of mass m are placed at the corners of an equilateral triangle of side a. The moment of inertia of this system about an axis along one side of the triangle is

(a) $3ma^2$ (b) ma^2

(c) $\frac{3}{4}ma^2$ (d) $\frac{3}{2}ma^2$

49. A pipe opened at both ends produces a note of frequency f_1. When the pipe is kept with $\frac{3}{4}$th of its length in water, it produces a note of frequency f_2. The ratio $\frac{f_1}{f_2}$ is

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

(c) $\frac{1}{2}$ (d) 2

50. A solenoid is 1.5 m long and its inner diameter is 4.0 cm. It has 3 layers of windings of 1000 turns each and carries a current of 2.0 A. The magnetic flux for a cross-section of the solenoid is nearly

(a) 4.1×10^{-5} Wb (b) 5.2×10^{-5} Wb

(c) 6.31×10^{-3} Wb (d) 2.5×10^{-7} Wb

Answer – Key

1.	a	**2.**	c	**3.**	a	**4.**	a	**5.**	d	**6.**	c	**7.**	b	**8.**	c	**9.**	d	**10.**	a
11.	c	**12.**	d	**13.**	d	**14.**	d	**15.**	a	**16.**	b	**17.**	b	**18.**	b	**19.**	d	**20.**	b
21.	b	**22.**	c	**23.**	c	**24.**	c	**25.**	b	**26.**	a	**27.**	b	**28.**	c	**29.**	b	**30.**	b
31.	b	**32.**	c	**33.**	b	**34.**	d	**35.**	b	**36.**	c	**37.**	a	**38.**	b	**39.**	a	**40.**	d
41.	c	**42.**	c	**43.**	a	**44.**	d	**45.**	a	**46.**	c	**47.**	c	**48.**	c	**49.**	c	**50.**	c

Hints and Solutions

1. From Coulomb's law,

The force of attraction or repulsion between two point charges q, q separated by distance r is

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2}$$

$$\Rightarrow \quad \varepsilon_0 = \frac{1}{4\pi}\frac{q^2}{Fr^2}$$

where ε_0 is electric permittivity.

$$\text{Dimensions of } \varepsilon_0 = \frac{[AT]^2}{[MLT^{-2}][L^2]}$$

$$\varepsilon_0 = [A^2M^{-1}L^{-3}T^4]$$

2. Force, $F = ma$

$$a = \frac{F}{m} = \frac{5\times10^4}{3\times10^7}\ \text{m/s}^2$$

$$a = \frac{5}{3}\times10^{-3}\ \text{m/s}^2$$

Since, $v^2 - u^2 = 2as$

$$v^2 - 0 = 2\times\frac{5}{3}\times10^{-3}\times3$$

$$v^2 = 10^{-2}$$

$$v = 0.1\,\text{m/s}$$

3. According to the equation of motion of the centre of mass

$$M\vec{a}_{CM} = \vec{F}_{ext}$$

If $\vec{F}_{ext} = 0$, $\vec{a}_{CM} = 0$

$$\vec{v}_{CM} = \text{constant}$$

ie, if no external force acts on a system the velocity of its centre of mass remains constant. Thus, the centre of mass may move but not accelerate.

4. On smooth inclined plane:

Acceleration of the body = $g\sin\theta$

If s be the distance travelled, then

$$s = \frac{1}{2}g\sin\theta\times t_1^2 \qquad \ldots(i)$$