PART – A (PHYSICS)

SECTION - A

(One Options Correct Type)

This section contains **20 multiple choice questions**. Each question has **four choices** (A), (B), (C) and (D), out of which **ONLY ONE** option is correct.

Q1. Given below are two statements : One is labelled as **Assertion A** and the other is labelled as **Reason R.**

Assertion A : For measuring the potential difference across a resistance of 600 Ω, the voltmeter with resistance 1000 Ω will be preferred over voltmeter with resistance 4000 Ω.

Reason R : Voltmeter with higher resistance will draw smaller current than voltmeter with lower resistance.

In the light of the above statements, choose the most appropriate answer from the options given below.

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

(B) **A** is not correct but **R** is correct

(C) Both **A** and **R** are correct but R is not the correct explanation of **A**

(D) **A** is correct but **R** is not correct

Q2. Two objects A and B are placed at 15cm and 25cm from the pole in front of a concave mirror having radius of curvature 40cm. The distance between images formed by the mirror is _____.

(A) 60cm (B) 40cm

(C) 160cm (D) 200cm

Q3. A coil is placed in magnetic field such that plane of coil is perpendicular to the direction of magnetic field. The magnetic flux through a coil can be changed :

A. By changing the magnitude of the magnetic field within the coil.

B. By changing the area of coil within the magnetic field.

C. By changing the angle between the direction of magnetic field and the plane of the coil.

D. By reversing the magnetic field direction abruptly without changing its magnitude.

Choose the most appropriate answer from the options given below :

(A) A, B and D only (B) A and B only

(C) A, B and C only (D) A and C only

Q4. The escape velocities of two planets A and B are in the ratio 1 : 2. If the ratio of their radii respectively is 1 : 3, then the ratio of acceleration due to gravity of planet A to the acceleration of gravity of planet B will be :

(A) $\frac{2}{3}$ (B) $\frac{4}{3}$

(C) $\frac{3}{4}$ (D) $\frac{3}{2}$

Q5. If the velocity of light c, universal gravitational constant G and Planck's constant h are chosen as fundamental quantities. The dimensions of mass in the new system is :

(A) $\left[h^{1/2} c^{1/2} G^{-1/2}\right]$ (B) $\left[h^{-1/2} c^{1/2} G^{1/2}\right]$

(C) $\left[h^{1} c^{1} G^{-1}\right]$ (D) $\left[h^{1/2} c^{-1/2} G^{1}\right]$

Q6. The Young's modulus of a steel wire of length 6m and cross-sectional area 3 mm^2, is 2×10^{11} N/m^2. The wire is suspended from its support on a given planet. A block of mass 4kg is attached to the free end of the wire. The acceleration due to gravity on the planet is $\frac{1}{4}$ of its value on the earth. The elongation of wire is (Take g on the earth = $10m/s^2$) :

(A) 1 cm
(B) 0.1 cm
(C) 1 mm
(D) 0.1 mm

Q7. Choose the correct statement about Zener diode :

(A) It work as a voltage regulator in forward bias behaves like simple pn junction diode in reverse bias.
(B) It works as a voltage regulation in both forward and reverse bais.
(C) It works as a voltage regulator in reverse bias behaves like simple pn junction diode in forward bias.
(D) It works as a voltage regulator only in forwards bias.

Q8. Given below are statements : One is labelled as **Assertion A** and the other is labelled as **Reason R.**

Assertion A : Two metallic spheres are charged to the same potential. One of them is hollow and another is solid, and both have the same radii. Solid sphere will have charge than the hollow one.

Reason R : Capacitance of metallic sphere depend on the radii of sphere.

In the light of the above statements, choose the correct answer from the options given below.

(A) **A** is false but **R** is true
(B) **A** is true but R is false
(C) Both **A** and **R** are true but **R** is **not** the correct explanation of **A**
(D) Both **A** and **R** are true and **R** is the correct explanation of **A**

Q9. In an amplitude modulation, a modulating signal having amplitude of X V is superimposed with a carrier signal of amplitude Y V in first case. Then, in second case, the same modulating signal is superimposed with different carrier signal of amplitude 2Y V. The ratio of modulation index in the two cases respectively will be :

(A) 1 : 1
(B) 2 : 1
(C) 4 : 1
(D) 1 : 2

Q10. Equivalent resistance between the adjacent corners of a regular n-sided polygon of uniform wire of resistance R would be :

(A) $\frac{(n-1)R}{n^2}$
(B) $\frac{(n-1)R}{n}$
(C) $\frac{n^2R}{n-1}$
(D) $\frac{(n-1)R}{(2n-1)}$

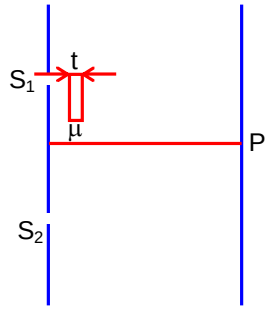
Q11. An electron of a hydrogen like atom, having Z = 4, jumps from 4^{th} energy state to 2^{nd} energy state. The energy released in this process, will be :

(Given Rch = 13.6 eV)
Where R = Rydberg constant
c = Speed of light on vacuum
h = Planck's constant

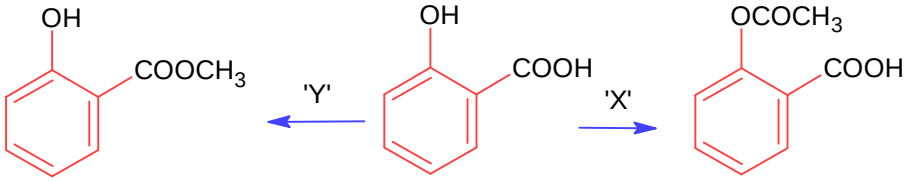
(A) 3.4 eV
(B) 40.8 eV
(C) 10.5 eV
(D) 13.6 eV

Q9. A force $F = (5 + 3y^2)$ acts on a particle in the y-direction, where F is in newton and y is in meter. The work done by the force during a displacement form y = 2m to y = 5m is _____J.

Q10. As shown in the figure, in Young's double slit experiment, a thin plate of thickness t = $10\,\mu$m and refractive index $\mu = 1.2$ is inserted infront of slit S_1. The experiment is conducted in air $(\mu = 1)$ and uses a monochromatic light of wavelength $\lambda = 500$ nm. Due to the insertion of the plate, central maxima is shifted by a distance of $x\beta_0$. β_0 is the fringe – width before the insertion of the plate. The value of the x is _____.



Q8. In a reaction



Reagents 'X' and 'Y' respectively are:
(A) $(CH_3CO)_2O/H^+$ and $CH_3OH/H^+,\Delta$
(B) CH_3OH/H^+, Δ and $(CH_3CO)_2O/H^+$
(C) $CH_3OH/H^+,\Delta$ and $CH_3OH/H^+,\Delta$
(D) $(CH_3CO)_2O/H^+$ and $(CH_3CO)_2O/H^+$

Q9. Which one of the following sets of ions represents a collection of isoelectronic species?
(Given: Atomic Number: F: 9, Cl: 17, Na = 11, Mg = 12, Al = 13, K = 19, Ca = 20, Sc= 21)
(A) Ba^{2+}, Sr^{2+}, K^+, Ca^{2+}
(B) Li^+, Na^+, Mg^{2+}, Ca^{2+}
(C) K^+, Cl^-,Ca^{2+}, Sc^{3+}
(D) N^{3-},O^{2-},F^-,S^{2-}

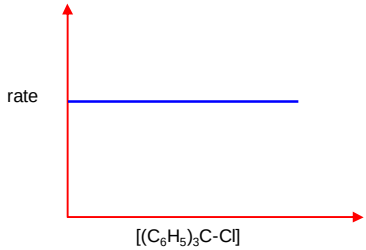
Q10. Which element is not present in Nessler's reagent?
(A) Oxygen
(B) Mercury
(C) Iodine
(D) Potassium

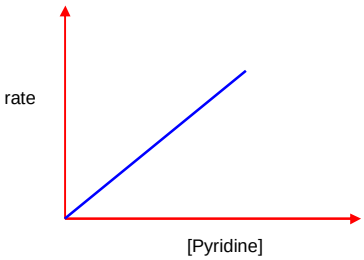
Q11. For electron gain enthalpies of the elements denoted as $\Delta_{eg}H$, the incorrect option is:
(A) $\Delta_{eg}H(I) < \Delta_{eg}H(At)$
(B) $\Delta_{eg}H(Te) < \Delta_{eg}H(P)$
(C) $\Delta_{eg}H(Cl) < \Delta_{eg}H(F)$
(D) $\Delta_{eg}H(S) < \Delta_{eg}H(S)$

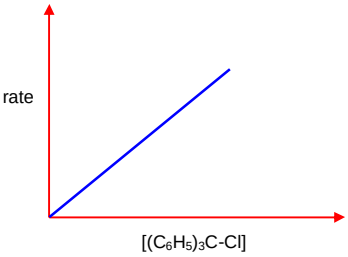
Q12. The graph which represents the following reaction is:

$$(C_6H_5)_3C-Cl \xrightarrow[\text{Pyridine}]{OH^-} (C_6H_5)_3C-OH$$

(A)

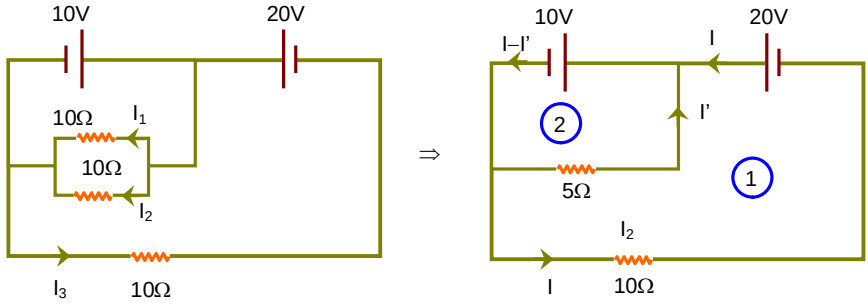

(B)


(C)


(D)


SECTION - B

Sol1. Applying KVL in loop – 1



Sol2. By using parallel axis theorem

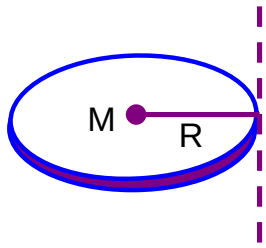
$$I = I_0 + MR^2$$

$$I = \frac{MR^2}{2} + MR^2$$

$$I = \frac{3}{2}MR^2$$

But $I = \frac{x}{2}MR^2$

So, $x = 3$



Sol3. Area $(A) = 70cm^2 = 70\times10^{-4}m^2$, B = 0.4 T

$$f = 500\ \frac{rev}{min} = \frac{500}{60}\ \frac{rev}{sec}$$

As we know that,

Induced emf in a coil is given by

$$e = N\omega BA\sin\theta$$

$$= 600\times2\times\frac{22}{7}\times\frac{500}{60}\times0.4\times70\times10^{-4}\sin30^\circ$$

$$= 44\,volt$$

Sol4. Using equation of continuity

$$A_1v_1 = A_2v_2$$

$$750\times10^{-4}\times v_1 = 500\times10^{-6}\times30\times10^{-2}$$

$$v_1 = 20\times10^{-4}\ m/sec$$

$$v_1 = 2\times10^{-3}\ m/sec$$

Given: $\frac{dh}{dt} = v = x\times10^{-3}\ m/sec$

$\therefore\ x = 2$

Sol5. As we know that the total energy for free oscillation remains constant.

So, Total energy is equal to $\frac{1}{2}m\omega^2A^2 = \frac{1}{2}kA^2$

$$\Rightarrow \frac{1}{2}kA^2 = 0.25\ J$$

$\Rightarrow A = B$

$\therefore R_1$ is reflexive and symmetric.

Again $\left.\begin{matrix} AR_1B \Rightarrow A = B \\ BR_1C \Rightarrow B = C \end{matrix}\right\} \Rightarrow A = C$

$\therefore R_1$ is transitive

Hence R_1 is equivalence relation.

AR_2B if $A \cup B^C = B \cup A^C$

$\Rightarrow V - B = V - A$

$\Rightarrow B = A$

$\therefore R_2$ is also reflexive, symmetric and transitive

R_2 is equivalence relation.

Sol9. $x_1 = 9$

$x_1 = 9, x_2 = 9 + d, x_3 = 9 + 2d, x_4 = 9 + 3d, x_5 = 9 + 4d$

$x_6 = 9 + 5d, x_7 = 9 + 6d$

$\vec{x} = \dfrac{d + 2d + 3d + 4d + 5d + 6d}{7} = 3d$

$16 = \dfrac{1}{7}\left(0^2 + 1^2 .... + 6^2\right) - 9d^2$

$16 = 4d^2$

$d = \pm 2, d > 0$

$d = 2$

$\bar{x} + x_6 = 15 + 19 = 34$

S.D = 4

$\vec{x} = 6$

$\sqrt{\dfrac{\left(0^2 + 1^2 .... 6^2\right)}{7}} = 4$

$\bar{x} + x_6 = 15 + 19 = 34$

Sol10. $3x^2 - 4y^2 = 36$

$\dfrac{dy}{dx} = \dfrac{3x}{4y} = \dfrac{3x_0}{4y_0}$

Point $\left(x_0, y_0\right)$ on curve.

$\dfrac{3x_0}{4y_0} = \dfrac{-3}{2}$

$x_0 = -2y_0$

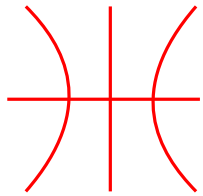
$3x_0^2 - 4y_0^2 = 36$

$y_0 = \pm 3/\sqrt{2}$ $\qquad$ $x_0 = -2y_0$

$\left(\dfrac{-6}{\sqrt{2}}, \dfrac{3}{\sqrt{2}}\right), \left(\dfrac{6}{\sqrt{2}}, \dfrac{-3}{\sqrt{2}}\right)$

Calculating $\perp$ distance from both co-ordinate

$\left(\dfrac{6}{\sqrt{2}}, \dfrac{-3}{\sqrt{2}}\right)$ is nearest to line.



$m = 7$

$^{7}C_{5}\left(10-3^{x}\right)^{\frac{2}{2}}\ 3^{x-2} = 21$

$\left(10-3^{x}\right)\cdot 3^{x} = 9$

$\left(10-t\right)\cdot t = 9$

$10t - t^{2} = 9$

$t^{2} - 10t + 9 = 0$

$t^{2} - 9t - t + 9 = 0$

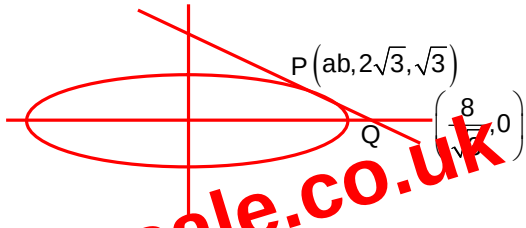
$t\left(t-9\right) - 1\left(t-9\right) = 0$

$\left(t-1\right)\left(t-9\right) = 0$

$t = 1, t = 9$

$3^{x} = 1, 3^{x} = 9 \Rightarrow x = 0, x = 2 \Rightarrow \left(0+2\right)^{2} = 4$

Sol9. $\frac{x^{2}}{a^{2}} + \frac{y^{2}}{b^{2}} = 1$



$\frac{a}{e} = 8, ab = 2$

$e = \frac{1}{2}$

$a = 4, b^{2} = 12$

equation of tangent at $\left(a\cos\theta, b\sin\theta\right)$

$\frac{x\cos\theta}{4} + \frac{y\sin\theta}{\sqrt{12}} = 1$

passing $Q\left(\frac{8}{\sqrt{3}}, 0\right)$

$\sin\theta = \frac{1}{2}$

$\theta = 30^{0}$

$PQ = \sqrt{\left(\sqrt{3}-0\right)^{2} + \left(2\sqrt{3} - \frac{8}{\sqrt{3}}\right)^{2}} = \sqrt{\frac{13}{3}}$

$\left(3PQ\right)^{2} = 9\left(PQ\right)^{2} = 9\times\frac{13}{3} = 39$

Sol10. $\left|\alpha\right| = 1 = 9\times\frac{13}{3} = 39$

$\left[x^{2/3} + \frac{\alpha}{x^{3}}\right)^{22}$

$T_{r+1} = {}^{22}C_{r}\ x^{\frac{44-2r}{3}-3r}$

$\frac{44-2r}{3} - 3r = 0$

$r = 4$

$T_{4+1} = T_{5} = {}^{22}C_{4}\ \alpha^{4} = 7315$

$\alpha^{4} = 1$

$\alpha = \pm 1 \qquad \left|\alpha\right| = 1$