Agniveer Vayu (Group XY) Official Model Paper

Physics

Q1 A body is moving in a circular path with acceleration a. If its velocity gets doubled then find the ratio of acceleration after and before the change of velocity?
(A) 1 : 4 (B) 1 : 2
(C) 2 : 1 (D) 4 : 1

Q2 Weightlessness of an astronaut moving in a satellite is a situation of -
(A) Zero velocity (B) No gravity
(C) Zero mass (D) Free fall

Q3 For which of the following metals, the resistance decreases on increasing the temperature?
(A) Copper (B) Tungsten
(C) Germanium (D) Aluminium

Q4 What is the angle of dip at magnetic poles of earth ?
(A) Zero (B) 45°
(C) 90° (D) 180°

Q5 A charge moves in a circle perpendicular to a magnetic field. Upon which of the following, the time period of revolution, does not depend?
(A) Magnetic field
(B) Charge
(C) Mass of the particle
(D) Velocity of the particle

Q6 Atomic number of a nucleus is Z and atomic mass is M . Find the number of neutrons.
(A) M-Z (B) M
(C) Z (D) M+Z

Q7 The electrical circuit, used to get smooth dc output from a rectifier circuit is called _______ .
(A) Oscillator (B) Filter
(C) Amplifier (D) Logic gate

Q8 Two bodies of 2 kg & 4 Kg are moving with velocities 20 m/ s and 10m/s respectively towards each other under mutual gravitational attraction. Find the velocity of their centre of mass in m/s.
(A) 5 (B) 6
(C) 8 (D) Zero

Q9 The radius of gyration of a solid sphere of radius r about a certain axis is r. Find the distance of this axis from the centre of the sphere.
(A) r (B) 0.5 r
(C) $\sqrt{0.4}r$ (D) $\sqrt{0.2}r$

Q10 Which of the following statements is correct, in case of adiabatic expansion?
(A) $\Delta U = 0$
(B) $\Delta U =$ ऋणात्मक / negative
(C) $\Delta U =$ धनात्मक / positive
(D) $\Delta W = 0$

Q11 The velocity of a particle, executing S.H.M, is ______ at its mean position.
(A) maximum (B) minimum
(C) infinity (D) zero

Q12 A coil of an area $2m^2$ is placed in a magnetic field which changes from $4Wb/m^2$ to $8\ Wb/m^2$ in 2 seconds. Find the induced e.m.f. in the coil.
(A) 4V (B) 5V
(C) 6V (D) 7V

Q13 The process by which an alternating current is converted into direct current is called _______ .
(A) Purification
(B) Amplification
(C) Rectification
(D) Current amplification

Q14 If the threshold wavelength for photoelectric effect on sodium metal is 5000 A° then find its work function.
(A) 15J

(B) 4×10^{-19} J
(C) 4×10^{-14} J
(D) 4×10^{-22} J

Q15 Through which mode of wave propagation, are the radio waves sent from one place to another?
(A) ground wave propagation
(B) sky wave propagation
(C) space wave propagation
(D) all of the above

Q16 What is the wavelength range of visible light?
(A) 4×10^{-7}m -8×10^{-7}m
(B) 4×10^{-6}m -8×10^{-8}m
(C) 4×10^{5}m -8×10^{-9}m
(D) 4×10^{10}m -8×10^{10}m

Q17 What is the dimensional formula for the universal gravitational constant ?
(A) $M^{-1}L^{3}T^{-2}$ (B) $M^{-1}L^{3}T^{-1}$
(C) $M^{-1}L^{2}T^{-2}$ (D) $M^{0}L^{0}T^{0}$

Q18 Two balls are dropped from heights h and 2 h respectively. What would be the ratio of times taken by the balls to reach the earth ?
(A) $\sqrt{2}$: 1 (B) 1:$\sqrt{2}$
(C) 2:1 (D) 4:119

Q19 When a spring is stretched by 2 cm , the energy stored is 100 J . If it is stretched further by 2 cm , its energy increases by _______ .
(A) 300 (B) 400
(C) 200 (D) 100

Q20 At what temperature, will the surface tension of water, be minimum?
(A) 0°C (B) 25°C
(C) 60°C (D) 75°C

Q21 Diameters of 2 water drops are 1 cm and 1.5 cm respectively. Find the ratio of excess pressures inside them.
(A) 1 : 1 (B) 5 : 3
(C) 3 : 2 (D) 2 : 3

Q22 In Young's double slit experiment, using sodium light $(\lambda = 5898\text{Å})$, 92 fringes are seen. If another colour ($\lambda = 5461\text{Å}$)is used then find the number of fringes.
(A) 62 (B) 99
(C) 67 (D) 85

Q23 Two plates are at potentials -10 V and +30 V . If the separation between the plates is 2 cm then find the electric field between them.
(A) 2000 V/m (B) 1000 V/m
(C) 500 V/m (D) 3000 V/m

Q24 If red light is replaced by blue light illuminating the object in a microscope, the resolving power of the microscope _______ .
(A) will decrease
(B) will increases
(C) will get halved
(D) will remain unchanged

Q25 In gases of diatomic molecules, Find the ratio of the two specific heat of gases $\frac{C_P}{C_V}$.
(A) 1.66 (B) 1.33
(C) 1.4 (D) 1.00

Answer Key

Q1	(D)
Q2	(D)
Q3	(C)
Q4	(C)
Q5	(D)
Q6	(A)
Q7	(B)
Q8	(D)
Q9	(C)
Q10	(B)
Q11	(A)
Q12	(A)
Q13	(C)
Q14	(B)
Q15	(D)
Q16	(A)
Q17	(A)
Q18	(B)
Q19	(A)
Q20	(D)
Q21	(C)
Q22	(B)
Q23	(A)
Q24	(A)
Q25	(C)

Hints & Solutions

Q1 Text Solution:

For a body moving in a circular path, the centripetal acceleration a is given by the formula:

$a = \frac{v^2}{r}$

where:

- v is the velocity of the body,
- r is the radius of the circular path.

If the velocity of the body is doubled, then the new velocity becomes $2v$. The new acceleration a' will be:

$a\prime = \frac{(2v)^2}{r} = \frac{4v^2}{r} = 4a$

The ratio of the new acceleration a' to the original acceleration a is:

$\frac{a\prime}{a} = \frac{4a}{a} = 4 : 1$

So the correct answer is:

Option D: $4 : 1$

Q2 Text Solution:

- The weightlessness of an astronaut moving in a satellite is a situation of:

Explanation:

- In a satellite orbiting the Earth, both the satellite and the astronaut inside are in a state of continuous free fall towards the Earth.
- However, since they are falling at the same rate, the astronaut experiences a sensation of weightlessness, as there is no normal force acting on them

Option D: Free fall

Q3 Text Solution:

The resistance of Germanium decreases on increasing the temperature.

Explanation:

- Germanium is a semiconductor, and for semiconductors, the resistance decreases with an increase in temperature.
- This is because, at higher temperatures, more charge carriers (electrons and holes) are generated, which enhances the conductivity and thereby reduces the resistance.

So, the correct answer is:

Option C: Germanium

Q4 Text Solution:

The angle of dip at the magnetic poles of the Earth is:

Explanation: The angle of dip (also known as magnetic inclination) is the angle that the Earth's magnetic field makes with the horizontal plane.

- At the magnetic poles, the magnetic field lines are vertical, so the angle of dip is 90°.

Option C: 90°

Q5 Text Solution:

- The time period of revolution for a charged particle moving in a circle perpendicular to a magnetic field is given by: T=2πη q/B
- T where: T is the time period, m is the mass of the particle, q is the charge of the particle, B is the magnetic field. From this formula, it is clear that the time period T depends on the mass m charge q, and magnetic field B, but it does not depend on the velocity of the particle.

So, the correct answer is:

Option D: Velocity of the particle

Q6 Text Solution:

- The number of neutrons in a nucleus is calculated by subtracting the atomic number Z (which represents the number of protons) from the atomic mass M (which represents the total number of protons and neutrons).
- So, the number of neutrons N is given by: N=M-Z

Therefore, the correct answer is: **Option A: M - Z**

Q7 Text Solution:

- The electrical circuit used to get a smooth DC output from a rectifier circuit is called a:

Explanation:
A filter is used in conjunction with a rectifier to smooth out the fluctuations in the rectified output, producing a more stable and smooth DC voltage.
The filter typically consists of capacitors, inductors, or a combination of both.
The correct answer is Option B: Filter

Q8 Text Solution:

The velocity of the center of mass (V_{cm}) of two bodies can be found using the formula: ☐
$V_{\mathrm{cm}}=\frac{m_1 v_1+m_2 v_2}{m_1+m_2}$
where:
- $m_1=2\ \mathrm{kg}$ and $v_1=20\ \mathrm{m}/\mathrm{s}$ (let's assume this velocity is in the positive direction),
- $m_2=4\ \mathrm{kg}$ and $v_2=-10\ \mathrm{m}/\mathrm{s}$ (negative because it's in the opposite direction).
Substituting the values:
$V_{\mathrm{cm}}=\frac{(2\times 20)+(4\times -10)}{2+4} \frac{40-40}{6}=\frac{0}{6}=0\ \mathrm{m}/\mathrm{s}$
Hnce the correct **option is D**

Q9 Text Solution:

The radius of gyration K is related to the moment of inertia I by the equation:
$I=MK^2$
For a solid sphere of mass M and radius r, the moment of inertia about an axis passing through its center is:
$I_{\text{center}}=\frac{2}{5}Mr^2$
Now, if the radius of gyration about a certain axis is r, we use the parallel axis theorem. According to the parallel axis theorem:
$I_{\text{axis}}=I_{\text{center}}+Md^2$
where d is the distance of the axis from the center. Substituting $K=r$:
$Mr^2=\frac{2}{5}Mr^2+Md^2$
Simplifying the equation:
$r^2=\frac{2}{5}r^2+d^2$
$d^2=r^2-\frac{2}{5}r^2=\frac{3}{5}r^2$
$d=\sqrt{\frac{3}{5}}r=\sqrt{0.6}r\approx 0.774r$
But the closest option to this value is:
Option C: $\sqrt{0.4}r$

Q10 Text Solution:

In the case of adiabatic expansion, the correct statement is:
Explanation:

- During adiabatic expansion, a gas expands without exchanging heat with its surroundings (Q = 0). The work done by the gas (W) is at the expense of its internal energy (U).
- Therefore, the internal energy decreases, making AU (change in internal energy) negative.

Hence the correct option is Option B: AU is negative (ऋणात्मक)

Q11 Text Solution:

In Simple Harmonic Motion (SHM), the velocity of a particle is:
Explanation:

- At the mean position (the equilibrium position), the particle's velocity is at its maximum because the particle is moving fastest through the equilibrium position.
- As the particle moves away from the mean position, the restoring force decreases, and the velocity decreases, reaching zero at the extreme positions.

Option A: Maximum

Q12 Text Solution:

To find the induced electromotive force (e.m.f.) in the coil, we use Faraday's Law of Electromagnetic Induction. The formula for the induced e.m.f. ($\mathcal{E}$) is:
$\mathcal{E}=-\frac{\Delta\Phi}{\Delta t}$
where: ☐
- $\Delta\Phi$ is the change in magnetic flux,
- Δt is the time over which the change occurs.

The magnetic flux (Φ) through the coil is given by:

$\Phi = B \times A$

where B is the magnetic field and A is the area of the coil.

1. Calculate the initial and final magnetic flux:

- Initial flux,

$\Phi_{\text{initial}} = B_{\text{initial}} \times A = 4\ \text{Wb/m}^2 \times 2\ \text{m}^2 = 8\ \text{Wb}$

- Final flux,

$\Phi_{\text{final}} = B_{\text{final}} \times A = 8\ \text{Wb/m}^2 \times 2\ \text{m}^2 = 16\ \text{Wb}$

2. Calculate the change in flux $(\Delta\Phi)$:

$\Delta\Phi = \Phi_{\text{final}} - \Phi_{\text{initial}} = 16\ \text{Wb} - 8\ \text{Wb} = 8\ \text{Wb}$

3. Calculate the induced e.m.f.:

$\mathcal{E} = \frac{\Delta\Phi}{\Delta t} = \frac{8\ \text{Wb}}{2\ \text{s}} = 4\ \text{V}$

So, the induced e.m.f. in the coil is:

Option A : 4V

Q13 Text Solution:

Explanation: Rectification is the process of converting AC to DC using devices like diodes or rectifiers.

Option C: Rectification

Q14 Text Solution:

To find the work function (ϕ) for the photoelectric effect, we use the formula:

$\phi = \frac{hc}{\lambda}$

where:

- h is Planck's constant $\left(6.626 \times 10^{-34} \text{Js}\right)$,
- c is the speed of light $\left(3 \times 10^8\ \text{m/s}\right)$,
- λ is the threshold wavelength.

Given:

- Threshold wavelength,

$\lambda = 5000\text{\AA} = 5000 \times 10^{-10}\ \text{m} = 5. \times 10^{-7}\ \text{m}$

Now calculate the work function:

$\phi = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{5 \times 10^{-7}}$

$\phi = \frac{1.9878 \times 10^{-25}}{5 \times 10^{-7}} = 3.9756 \times 10^{-19}\ \text{J}$

Rounding to the nearest significant figure, we get:

$\phi \approx 4 \times 10^{-19}\ \text{J}$

So, the correct answer is:

Option B: $4 \times 10^{-19}\ \text{J}$

Q15 Text Solution:

Radio waves can be sent from one place to another using different modes of wave propagation depending on the frequency of the radio waves and the distance between the transmitter and receiver. These modes include:

- A. Ground wave propagation: Suitable for low-frequency radio waves, which travel along the Earth's surface.
- B. Sky wave propagation: Suitable for medium-frequency radio waves, which are reflected by the ionosphere and can cover long distances.
- C. Space wave propagation: Suitable for high-frequency radio waves, which travel directly through the atmosphere and can be used for line-of-sight communication over shorter distances or via satellites.

So, the correct answer is:

option D. All of the above

Q16 Text Solution:

The wavelength range of visible light is:

Option A: $4 \times 10^{-7}\ \text{m}$ **to** $8 \times 10^{-7}\ \text{m}$

Explanation:

Visible light wavelengths range from approximately 400 nm (nanometers) to 700 nm , which corresponds to $4 \times 10^{-7}\ \text{m}$ to $8 \times 10^{-7}\ \text{m}$.

Q17 Text Solution:

The universal gravitational constant G has the formula for gravitational force given by:

$F = \frac{G m_1 m_2}{r^2}$

where:

- F is the force (with dimensional formula $\left[M L T^{-2}\right]$),
- m_1 and m_2 are masses (with dimensional formula $[M]$),

- r is the distance (with dimensional formula $[L]$).

Rearranging to solve for G :

$G=\frac{F \cdot r^2}{m_1 \cdot m_2}$

Substituting the dimensional formulas:

$[G]=\frac{\left[M L T^{-2}\right] \cdot\left[L^2\right]}{[M]^2}=\frac{M L^3 T^{-2}}{M^2}$

$=M^{-1} L^3 T^{-2}$

So, the dimensional formula for the universal gravitational constant G is:

Option A: $M^{-1} L^3 T^{-2}$

Q18 Text Solution:

To find the ratio of the times taken by two balls dropped from different heights we use the following kinematic equation for free fall:

$h=\frac{1}{2} g t^2$

where h is the height, g is the acceleration due to gravity, and t is the time tak

For the first ball dropped from height h :

$h=\frac{1}{2} g t_1^2 \Longrightarrow t_1=\sqrt{\frac{2 h}{g}}$

For the second ball dropped from height $2 h$:

$2 h=\frac{1}{2} g t_2^2 \Longrightarrow t_2=\sqrt{\frac{4 h}{g}}$

Now, calculate the ratio $\frac{t_2}{t_1}$:

$\frac{t_2}{t_1}=\frac{\sqrt{\frac{4 h}{g}}}{\sqrt{\frac{2 h}{g}}}=\sqrt{\frac{4 h}{2 h}}=\sqrt{2}$

Thus, the ratio of the times taken by the balls to reach the Earth is:

Option B: $1: \sqrt{2}$

Q19 Text Solution:

The energy E stored in a spring is given by:

$E=\frac{1}{2} k x^2$

where:

- k is the spring constant,
- x is the displacement from the equilibrium position.

When the spring is stretched by $2 \mathrm{~cm}(x=2 \mathrm{~cm}=0.02 \mathrm{~m})$, the energy stored is $100 \mathrm{~J}$:

$100=\frac{1}{2} k(0.02)^2$

To find k :

$100=\frac{1}{2} k(0.0004)$

$k=\frac{100 \times 2}{0.0004}=500000 \mathrm{~N} / \mathrm{m}$

When the spring is stretched further by an additional 2 cm (making it a total of 4 cm or 0.04 m), the new energy stored is:

$E_{\text {new }}=\frac{1}{2} k(0.04)^2$

Substituting k :

$E_{\text {new }}=\frac{1}{2} \times 500000 \times(0.0016)=400 \mathrm{~J}$

The increase in energy:

$\Delta E=E_{\text {new }}-E_{\text {old }}=400-100=300 \mathrm{~J}$

So, the energy increases by:

Option A: 300

Q20 Text Solution:

- The surface tension of water decreases with increasing temperature. This is because the intermolecular forces become weaker at higher temperatures, leading to a reduction in surface tension.
- Therefore, the surface tension of water will be minimum at the highest temperature given.

So, the correct answer is:

Option D: 75°C

Q21 Text Solution:

The excess pressure inside a spherical water drop is given by:

$P_{\text {excess }}=\frac{2 \gamma}{r}$

where:

- γ is the surface tension of the water,
- r is the radius of the drop.

Given the diameters of the two drops:

- $d_1=1 \mathrm{~cm}$ (radius $r_1=0.5 \mathrm{~cm}$),
- $d_2=1.5 \mathrm{~cm}$ (radius $r_2=0.75 \mathrm{~cm}$).

The excess pressures inside the drops are:

$P_{\text {excess },1}=\frac{2 \gamma}{r_1}=\frac{2 \gamma}{0.5}=4 \gamma$

$P_{\text {excess },2}=\frac{2 \gamma}{r_2}=\frac{2 \gamma}{0.75}=\frac{8 \gamma}{3}$

To find the ratio of excess pressures:

$\frac{P_{\text {excess },1}}{P_{\text {excess },2}}=\frac{4 \gamma}{\frac{8 \gamma}{3}}=\frac{4 \gamma \times 3}{8 \gamma}=\frac{12}{8}=\frac{3}{2}$

So, the correct ratio of excess pressures is:

Option C: $3: 2$

Q22 Text Solution:

In Young's double slit experiment, the number of fringes visible on the screen is proportional to the wavelength of the light used. The formula for the number of fringes is given by:

$N \propto \frac{1}{\lambda}$

where N is the number of fringes and λ is the wavelength of light.

Given:

- Wavelength of sodium light, $\lambda_1 = 5898 \text{Å}$
- Number of fringes with sodium light, $N_1 = 92$
- Wavelength of the new color, $\lambda_2 = 5461 \text{Å}$

We need to find the number of fringes N_2 with the new color. We can use the ratio of wavelengths to find this:

$\frac{N_1}{N_2} = \frac{\lambda_2}{\lambda_1}$

Rearranging to solve for N_2 :

$N_2 = N_1 \times \frac{\lambda_1}{\lambda_2}$

Substitute the given values:

$N_2 = 92 \times \frac{5898}{5461}$

Calculate:

$N_2 \approx 92 \times 1.08 \approx 99.36$

Rounding to the nearest integer:

$N_2 \approx 99$

So, the number of fringes with the new color is:

Option B: 99

Q23 Text Solution:

The electric field E between two plates can be calculated using the formula:

$E = \frac{V}{d}$

where:

- V is the potential difference between the plates,
- d is the separation between the plates.

Given:

- Potential difference $V = 30 \text{ V} - (-10 \text{ V}) = 40 \text{ V}$
- Separation $d = 2 \text{ cm} = 0.02 \text{ m}$

Substitute the values:

$E = \frac{40 \text{ V}}{0.02 \text{ m}} = 2000 \text{ V/m}$

So, the electric field between the plates is:

Option A: 2000 V/m

Q24 Text Solution:

The resolving power of a microscope is given by:

$R \propto \frac{1}{\lambda}$

- where R is the resolving power and λ is the wavelength of light used.
- Since blue light has a shorter wavelength than red light, the resolving power of the microscope will increase when blue light is used instead of red light.

Therefore, the correct answer is:

Option B: will increase

Q25 Text Solution:

For diatomic gases, the ratio of the specific heats $\frac{C_p}{C_v}$ (where C_p is the specific heat at constant pressure and C_v is the specific heat at constant volume) can be calculated using the following relation:

$\frac{C_p}{C_v} = \gamma$

where γ (gamma) is the adiabatic index.

For diatomic gases, γ is approximately:

$\gamma = \frac{C_p}{C_v} = \frac{7}{5} = 1.4$

So, the ratio of the specific heats $\frac{C_p}{C_v}$ for diatomic gases is:

Option C: 1.4