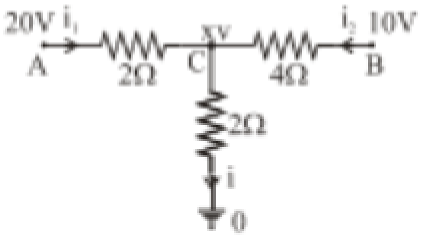
50 Important Questions of Physics for Air Force Group X Exam 2019

Solution Set

1. Ans.



Let voltage at C = xv

KCL : $i_1 + i_2 = i$

$$\frac{20-x}{2}+\frac{10-x}{4}=\frac{x-0}{2}$$

$$\Rightarrow x=10$$

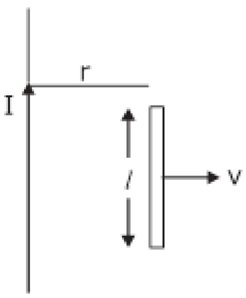
2. Ans.

$$Q=\frac{\Delta\phi}{R}=\frac{1}{10}A(B_2-B_1)=\frac{1}{10}\times 3.5\times 10^{-5}\left(n.4\sin\frac{\pi}{2}-0\right)$$

$$=\frac{1}{10}(3.5\times 10^{-3})(0.4-0)$$

$= 1.4 \times 10^{-4} = 0.14$ mC $= 14 \times 10^{-5}$

3. Ans. B.



For the magnetic field

$$B = \frac{\mu_0 I}{2\pi r}$$

For induced emf

$$\varepsilon = Bv\ell$$

$$\varepsilon = \frac{\mu_0 I}{2\pi r} v\ell$$

4. Ans. D.

If the battery is short circuited it's terminal voltage E − ir = 0

If the battery is getting discharged, E − ir = V

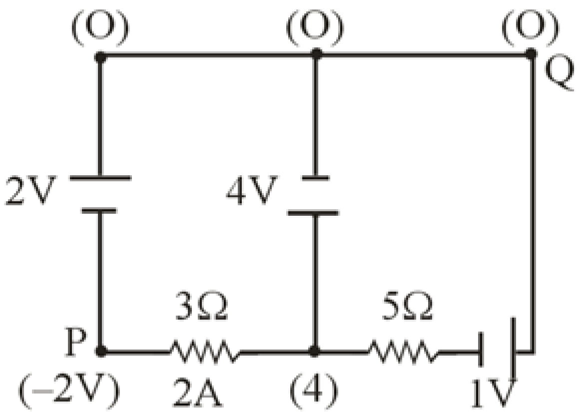
If the battery is getting charged, E + ir = V

So terminal voltage may be = O, >E or <E.

D is the correct option.

5. Ans. C.

This circuit can be represented equivalently as shown below:



Potential in volts is indicated in brackets.

$$V_{PQ} = V_P - V_Q = (-2) - (O) = -2V$$

C is the correct option.

6. Ans. C.

Resistance of wire is $(R) = \rho \frac{l}{A}$

If wire is bent in the middle then

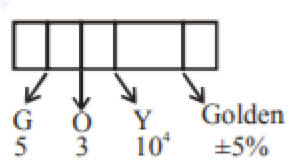
$$l' = \frac{l}{2}, A' = 2A$$

∴ New resistance, $R' = \rho \frac{l'}{A'}$

$$= \frac{\rho \frac{l}{2}}{2A} = \frac{\rho l}{4A} = \frac{R}{4}$$

7. Ans. A.

From color coding table resistance is



$$R = 53 \times 10^4 \pm 5\% = 530\ k\Omega \pm 5\%$$

8. Ans. C.

If the coil is broken at any point, then the induced emf will be generated in it but no induced current will flow. In this condition the coil will not oppose the motion of the magnet and the magnet will fall freely with acceleration g.

9. Ans. B.

The braking force decreases as the velocity decreases. When the conductive sheet is stationary, the magnetic field through each part of it is constant, not changing with time, so no eddy currents are induced, and there is no force between the magnet and the conductor.

10. Ans. B.

Power factor

$$\cos\phi = \frac{R}{Z}$$

In choke coil, Φ = 90°
So, cosΦ = 0

The power factor of a yard choke is zero.

11. Ans. B.

$$F_{net} = \sqrt{8^2 + 6^2}\,N = 10\ N$$

$$a = \frac{F_{net}}{M} = \frac{10\ N}{5\,kg} = 2\,m/s^2$$

12. Ans. C.

$$T = \left(\frac{2m_1m_2}{m_1 + m_2}\right)g = \frac{2(8\ kg)(12\,kg)}{(20\ kg)}(10\,m/s^2)$$

= 96 N.

13. Ans. A.

Case I-
T – 40(10) = 40a
T – 40(10) = 40(6)
T = 640 N

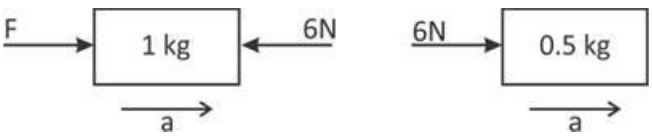
Case II-
(40) (10) –T = (40)(4)
T = 240 N

Case III-
T – 40(10) = 40(5)
T = 600 N

Case IV-
T = 0 N

14. Ans. D.

As the contact forces between the blocks is 6 N, the F.B.D. of the blocks is



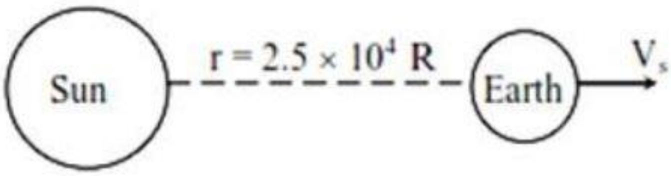
F − 6 = 1a and 6 = 0.5 a $\Rightarrow a = \frac{6}{0.5} = 12\ m/s^2.$

15. Ans. B.

16. Ans. D.

17. Ans. B.

Energy conservation



$$\frac{1}{2}mV_s^2 - \frac{GM_em}{R} - \frac{GM_sm}{r} = 0$$

$$\frac{1}{2}mV_s^2 = \frac{GM_em}{R} + \frac{GM_sm}{r}$$

$$V_s^2 = 2G\left[\frac{M_e}{R} + \frac{3\times10^5M_e}{2.5\times10^4R}\right]$$

$$V_s^2 = \frac{2GM_e}{R}[1+12] = 13\times\frac{2GM_e}{R}$$

$$V_e = \sqrt{\frac{2GM_e}{R}}$$

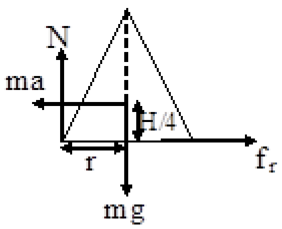
$$V_s = \sqrt{13}\,V_e = 3.6\times11.2 \approx 40.32\ \text{km/s}$$

18. Ans. C.

F_{max} for no sliding between cone and plank is

$\mu \times (m + M)g = \frac{1}{4}\times2\times10 = 5$ N

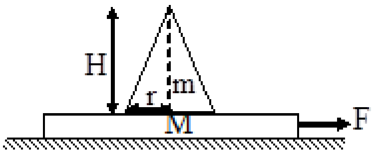
For toppling of cone



$T \circlearrowleft \geq T \circlearrowright$

i.e. $\frac{mF}{M+m} \times \frac{H}{4} \geq mgr$ $\Rightarrow$ $F \geq 4(M+m)g\frac{r}{H}$ $\Rightarrow$ $F \geq 4$

∴ Toppling will occur before sliding.

∴ F_{max} for equilibrium = 4 N 

19. Ans. D.

Semi-major axis $= \frac{3+3R}{2} = 2R$

∴ Total energy of the orbit $= -\frac{GMm}{2(2R)} = -\frac{GMm}{4R}$

∵ Total energy = KE + PE

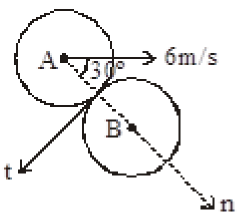
∴ $-\frac{GMm}{4R} = \frac{1}{2}mv^2 - \frac{GMm}{R}$

$\Rightarrow$ $v = \sqrt{\frac{3}{2}\frac{GM}{R}}$

20. Ans. B.

Using COM, along n–direction gives
$m6\cos 30^\circ + 0 = m(v_1)_n + m(v_2)_n$

and $0.6 = \frac{(v_2)_n - (v_1)_n}{6\cos 30^\circ - 0}$



$\Rightarrow$ $(v_1)_n = 1.039 m/s$

and $(v_2)_n = 4.16 m/s$.

21. Ans. A.

Using COM along t–direction gives

$(v_1)_t = 6\sin 30^\circ = 3\ m/s$

$\therefore\ v_1 = \sqrt{(1.039)^2 + (3)^2} = 3.17\ m/s$.

22. Ans. C.

$K_i = \frac{1}{2}m(6)^2 + 0 = 18m$

$K_f = \frac{1}{2}m(3.17)^2 + \frac{1}{2}m(4.16)^2 = 13.68\ m$

% loss $= \frac{18m - 13.68m}{18m} \times 100 = 24\%$

23. Ans. C.

By the conservation of momentum, in the absence of external force total momentum of the system (ball + earth) remains constant.

24. Ans. A.

Dimension of Curie is T^{-1}

Light year is used for measuring distance, hence its dimension is L

Dimension of atomic weight is M and Decibel is a dimensionless quantity

25. Ans. C.

$R = \frac{mv\sin\theta}{qB} \Rightarrow v\sin\theta = 1.2 \times 10^7\ m/s$ (Charge of α-particle = 3.2×10^{-19} c]

$P = \frac{2\pi m}{qB}v\cos\theta \Rightarrow v\cos\theta = \frac{PqB}{2\pi m} = q \times 10^6\ m/s$

$\therefore\ V_\alpha = \sqrt{(v\sin\theta)^2 + (v\cos\theta)^2} = 1.5 \times 10^7\ m/s$

26. Ans. B.

$m_y v_y = m_\alpha v_\alpha \Rightarrow v_y \approx 2.715 \times 10^5\ m/s$

∴ TE released during an α-decay of the nucleus X is,

$E = KE_y + KE_\alpha = \frac{1}{2}m_y v_y^2 + \frac{1}{2}m_\alpha v_\alpha^2 = 4.7MeV$

27. Ans. D.

Mass lost during α-decay, $\Delta m = \frac{E}{931} = 0.005U$

∴ mass of nucleus X,

$m_x = m_y + m_\alpha + \Delta m = 225.038U$

∴ mass defect in nucleus X,

$m_d = \{[92m_p + (225-92)m_n] - m_x\}U = 1.895U$

∴ BE per nucleon in nucleus X = $\frac{m_d \times 931}{225} = 7.84MeV$

28. Ans. A.

0.9 N_0 = N_0e^{-lt}

$\Rightarrow \quad \lambda = \frac{1}{t}\ln\left(\frac{10}{9}\right)$

$N' = N_0e^{-\lambda.2t} = N_0\left(\frac{9}{10}\right)^2 = \frac{81N_0}{100}$

∴ decayed = 19%.

29. Ans. C.

Time measured by moving observer will be $t = \frac{t_o}{\sqrt{1-\frac{v^2}{c^2}}}$

$t = \frac{4.0}{\sqrt{1-\frac{0.16c^2}{c^2}}}$

$t = \frac{4.0}{0.91}$

$t = 4.4s$

30. Ans. C.

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31. Ans. D.

In a Ruby laser, the colour of laser light is due to chromium atom.

32. Ans. D.

Black body- A black body is an object that is a perfect absorber of electromagnetic radiation. It doesn't reflect light at all.
A perfectly black body neither reflects nor transmit. (i.e.r=0,t=0) any part of the incident radiative energy but absorb whole of it or we can say its absorptive power is 1.

33. Ans. A.

We know,

$$\lambda = \frac{h}{m_1 v_1}$$

Therefore,

$$\frac{m_2}{m_1} = \frac{v_1}{v_2}$$

Thus,

$$\frac{v_1}{v_2} = \frac{4}{1}$$

34. Ans. B.

The momentum of the incident radiation is given as P = $\frac{h}{\lambda}$

When the light is totally reflected normal to the surface the direction of the ray is reversed. That means it reverses the direction of its momentum without changing its magnitude.

⇒ Change in momentum has a magnitude

$\Delta P = 2P = \frac{2h}{\lambda}$

⇒ $\Delta P = \frac{2(6.63 \times 10^{-34}\, J - sec)}{(6630 \times 10^{-10} m)} = 2 \times 10^{-27}$ kgm/s

Hence B. is correct.

35. Ans. D.

de-Broglie wavelength λ = h/mv

where the speed (r.m.s) of a gas particle at the given temperature (T) is given as

$$\frac{1}{2}mv^2 = \frac{3}{2}KT$$

$\Rightarrow v = \sqrt{\frac{3KT}{m}}$, where K = Boltzmann's constant, m = mass of the gas particle and T = temperature of the gas in K

$\Rightarrow mv = \sqrt{3mKT}$

$$\Rightarrow \lambda = \frac{h}{mv} = \frac{h}{\sqrt{3mKT}}$$

$$\therefore \frac{\lambda_H}{\lambda_{He}} = \sqrt{\frac{m_{He}T_{He}}{m_H T_H}} = \sqrt{\frac{(4amu)(273+127)^\circ K}{(2amu)(273+27)^\circ K}} = \sqrt{\frac{8}{3}}$$

Hence D. is correct.

36. Ans. A.

de-Broglie wavelength $\lambda = \frac{h}{\sqrt{2mE_e}} = \frac{hc}{E_{ph}}$

$$2mE_e = \frac{E_{ph}^2}{c^2} \text{ Since } E_e = \frac{1}{2}mv^2 \Rightarrow m = \frac{2E_e}{v^2}$$

$$\text{So, } 2\left[\frac{2E_e}{v^2}\right]E_e = \frac{E_{ph}^2}{c^2}$$

$$\frac{4E_e^2}{v^2} = \frac{E_{ph}^2}{c^2}$$

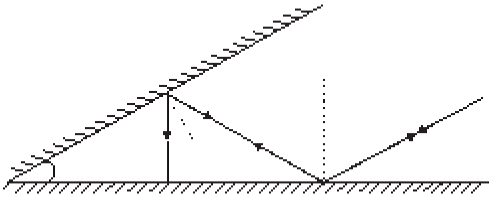
$$\frac{E_e^2}{v^2} = \frac{E_{ph}^2}{4c^2}$$

$$\frac{E_e}{E_{ph}} = \frac{v}{2c}$$

$$\frac{E_e}{E_{ph}} = \frac{\frac{35c}{100}}{2c}$$

$$\frac{E_e}{E_{ph}} = \frac{7}{40}$$

37. Ans. B.



For retracting the path, ray diagram shall be as shown in figure.

At point A

∠I = ∠r

90 = ∠I = 90 - ∠r

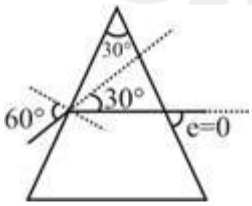
90 – θ = 2θ

90 = 3θ

θ = 30°

38. Ans.

I = 60°, d = 30° and A = 30°



d = I + e – A ⇒ e = 0

$r_1 = i - \Delta = 60 - 30 = 30^0 \; (\because \; e = 0)$

$\therefore \frac{\sin i}{\sin r_1} = \frac{\sin 60}{\sin 30} = \sqrt{3}$

∴ a = 3

39. Ans. B.

$R_1 = R$

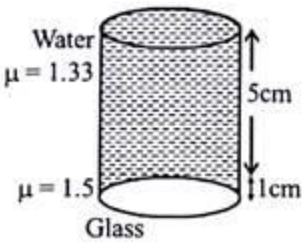
$R_2 = R + DR$

∴ diverging

$$P = (\mu - 1)\left(-\frac{1}{R} + \frac{1}{R+DR}\right) < 0$$

40. Ans. C.

Given that the real depth = 5 cm + 1 cm = 6 cm



Apparent depth $= \frac{d_1}{\mu_1} + \frac{d_2}{\mu_2}$

$$d' = \frac{5}{1.33} + \frac{1}{1.5}$$

$$d' \simeq 3.8 + 0.7 = 4.5 \text{ cm}$$

$$\text{Shift} = 6 \text{ cm} - 4.5 \text{ cm} \cong 1.5 \text{ cm}$$

41. Ans. D.

Myopia is shortsightedness and image is formed in front of retina. Hypermetropia is farsightedness and image is formed behind the retina.

42. Ans. A.

Light from a single point of a distant object and light from a single point of near an object are brought to focus with the help of a lens. Crystalline lens helps to form an inverted image on the retina as it biconvex lens.

43. Ans. A.

As the ray of light is incident at glass at polarizing angle (i_p), so the reflected and refracted rays are perpendicular to each other.
If r is the angle of refraction, then
$I_p + r = 90^o$
$r = 90^o - I_p$
Here, $I_p = 57^o$
$\therefore r = 90^o - 57^o = 33^o$

44. Ans. D.

For a diatomic molecule

Average Translational Kinetic energy

$K_T = \frac{3}{2}RT$

Average Rotational Kinetic energy

$K_R = \frac{2}{2}RT = RT$

Ratio = $\frac{K_T}{K_R} = \frac{\frac{3}{2}RT}{RT} = \frac{3}{2}$

45. Ans. C.

For isothermal Compression

As U = nCv T

For T → Constant

U → Constant.

The increase in pressure is due to increase in no. of Collisions.

46. Ans. B.

For ideal gas behavior

→ distance between molecules shall be larger.

→ they shall be moving at high speed.

Hence, it should be low pressure and high temperature.

47. Ans. A.

For rotating kinetic energy per molecule.

$(KE)_r = 2 \times \frac{1}{2}KT = KT$ (since diatomic gas has 2 rotational degrees of freedom)

As Temperature is same for both rotational kinetic energy per molecule will be same as well.

Option A. 1 : 1

48. Ans. B.

The number of molecules in 100 g of O_2 = $\frac{6.02\times10^{23}\times100}{32} = 1.88\times10^{24}$

The oxygen is a diatomic molecule and has 5 degrees of freedom,

Therefore, Energy associated with it = $1.88\times10^{24}\times\frac{5}{2}\times k_b\times T$

= $1.88\times10^{24}\times\frac{5}{2}\times1.38\times10^{-23}\times303$

=1.965 X 10^4 J

49. Ans. B.

CO is diatomic gas, for diatomic gas

$C_P = \frac{7}{2}R$ and $C_V = \frac{5}{2}R$ $\Rightarrow$ $\gamma_{di} = \frac{C_P}{C_V} = \frac{7R/2}{5R/2} = 1.4$

50. Ans. B.

The average translational energy of a molecule is given by the equipartition theorem as,

E= 3/2 KT where K is Boltzmann constant and T is the temperature(K).