Answers to 2024 JC2 Prelim Exam Paper 1 (H2 Physics)

1	**C**	**6**	**B**	**11**	**B**	**16**	**C**	**21**	**D**	**26**	**A**
2	**A**	**7**	**C**	**12**	**C**	**17**	**D**	**22**	**B**	**27**	**A**
3	**C**	**8**	**A**	**13**	**A**	**18**	**B**	**23**	**A**	**28**	**B**
4	**B**	**9**	**D**	**14**	**D**	**19**	**C**	**24**	**D**	**29**	**C**
5	**A**	**10**	**A**	**15**	**B**	**20**	**D**	**25**	**B**	**30**	**A**

Suggested Solutions:

1 Assume that the diameter of the cross-section of the wire in a paper clip is 1 mm.

Cross-sectional area of the wire in a paper clip $= \pi\left(\dfrac{0.001}{2}\right)^2 = 7.85\times10^{-7}\ \text{m}^2 \approx 8\times10^{-7}\ \text{m}^2$

Answer: C

2

Using $v^2 = u^2 + 2as = 0 + 2(9.81)(2.5)$

$\rightarrow \quad v = 7.0\ \text{m s}^{-1}$

Using $s = ut + \frac{1}{2}at^2$

$\rightarrow \ 0.12 = 7.0t + \frac{1}{2}(9.81)t^2$

$\rightarrow \quad t = 0.017\ \text{s}$

Answer: A

3 Applying conservation of momentum,

$$0 = m_1v_1 + \left(-m_2v_2\right)$$
$$m_1v_1 = m_2v_2$$
$$\frac{v_1}{v_2} = \frac{m_2}{m_1}$$

Answer: C

4 By resolving each forces into its vertical and horizontal components, only option B is most likely to be in equilibrium.

Answer: B

5 Using conservation of energy,

loss in G.P.E. = gain in K.E. + work done against frictional force

$$mgh = \frac{1}{2}mv^2 + f(200)$$
$$(60)g(50) = \frac{1}{2}(60)(20)^2 + f(200)$$
$$f = 87 \text{ N}$$

Answer: A

6 For circular motion at the highest point,

$$mg - N = \frac{mv^2}{r}$$
$$W - \frac{W}{3} = \frac{mv^2}{r}$$
$$mg - \frac{mg}{3} = \frac{mv^2}{r}$$
$$\frac{2mg}{3} = \frac{mv^2}{r}$$
$$v = \sqrt{\frac{2gr}{3}}$$

Answer: B

7 $F_g - N = F_c$

$$\frac{GMm}{R^2} - N = mR\left(\frac{2\pi}{T}\right)^2$$

Since N = 0,
$$\frac{GMm}{R^2} = mR\left(\frac{2\pi}{T}\right)^2$$
$$T = 2\pi\sqrt{\frac{R^3}{GM}}$$

Answer: C

8 acceleration, $a = a_0 \sin \omega t$

displacement, $x = -x_0 \sin \omega t$

$$= -x_0 \sin\left[\left(\frac{2\pi}{T}\right)\left(\frac{T}{3}\right)\right]$$

$$= -x_0 \sin\left(\frac{2\pi}{3}\right)$$

$$= -0.87 x_0$$

Answer: A

9 A and B are correct as they are valid assumptions in the simple kinetic theory of gases, i.e. how ideal gases particles should behave.

C is correct as the total energy of the system must remain constant due to the system being isolated.

D is not correct – given that the initial momentum of a molecule before collision is *p*, there will be a change in momentum of 2*p* because the final momentum of the molecule will be –*p* (same magnitude, opposite in direction).

Answer: D

10 The pressure of a gas is derived from the forces of collision between the molecules and the container walls, and not intermolecular collisions nor the energy transfer to the walls.

C will lead to a decrease in pressure instead, as the time interval between collisions will increase.

Answer: A

11 Using the equation $Q = mc\Delta T$

$$\frac{3}{4} \times \frac{1}{2} mv^2 = mc\Delta T$$

$$\Delta T = \frac{3v^2}{8c}$$

Answer: B

12 Phase difference

$$\Delta\phi = \left(\frac{5.0 \sin 30^\circ}{10}\right) \times 2\pi$$

$$= 1.6 \text{ rad}$$

Answer: C

13 By Malu's law, $A_f = A\cos\theta$

Since $I \propto A^2$, $I_f = k(A\cos\theta)^2 = kA^2\cos^2\theta$

Since power is proportional to intensity, power is proportional to $A^2\cos^2\theta$.

Answer: A

14 In order to get destructive interference at Q, the path difference of waves moving between P and Q should be (m – 0.5) λ.

Hence, path difference $= PS_1Q - PS_2Q = (l_1 + l_3) - (l_2 + l_4) = \left(\dfrac{2m-1}{2}\right)\lambda$

Answer: D

15 Using Rayleigh Criterion,

min angle of resolution between the two pixels, $\theta \approx \dfrac{\lambda}{b} = \dfrac{550\times10^{-9}}{2.0\times10^{-3}} = 2.75\times10^{-4}$ rad

$$\tan\left(\frac{\theta}{2}\right) = \frac{x/2}{D}$$

$$\begin{aligned} x &= 2D\tan\left(\frac{\theta}{2}\right) = 2(0.76)\tan\left(\frac{2.75\times10^{-4}}{2}\right) \\ &= 2.1\times10^{-4}\text{ m} \\ &= 0.21\text{ mm} \end{aligned}$$

Answer: B

16 At equilibrium,

$$F_E = \frac{qV}{d} = mg$$

When d is twice, F_E is reduced by half,

$$F_E' = \frac{1}{2}mg$$

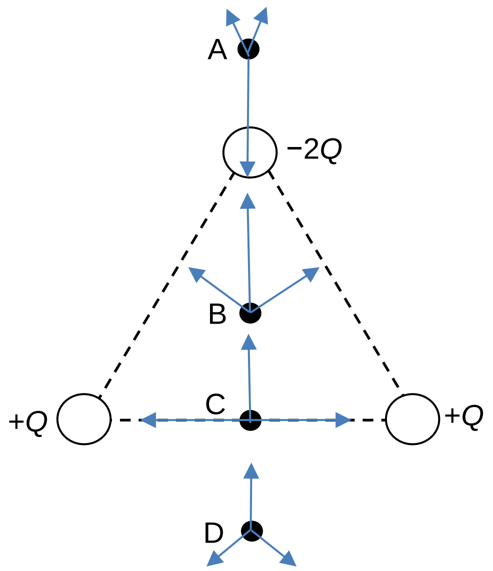
$$F_{resultant} = mg - \frac{1}{2}mg = 0.5mg = ma$$

$$a = 0.5g$$

Oil drop accelerates downwards as weight is now greater than upward electric force.

Answer: C

17 The forces due to the charges at different positions are shown.



$F \alpha \frac{q_1 q_2}{r^2}$

At A, the force due to the negative charge −2Q is much larger than the vector sum of forces due to the 2 positive charges +Q. Hence, there is a net downward force.

At B and C, the direction of resultant force on test charge is upwards.

Answer: D

18 $I = Anvq = (ac)n\left(\frac{b}{t}\right)q = \frac{nq}{t}(abc) = \frac{nqV}{t}$

Answer: B

19 From Fig. 19.1, when the current is 5 mA, the p.d. across the diode is 0.8 V
The p.d. across the 50 Ω resistor is given by V = (5 mA)(50 Ω) = 0.25 V
So the p.d. across the supply = 0.8 + 0.25 = 1.05 V

Answer: C

20 Potential at X is 12 V
The p.d. between X and Y = p.d. across the 3 Ω resistor = (1)(3) = 3 V
So the potential at Y is 12 – 3 = 9 V

Answer: D

21 By Fleming's left-hand rule, F is perpendicular to B.

Answer: D

22 Work done is required on the loop to maintain uniform speed, when the right edge of the square loop is out of the magnetic field and only the left edge is in the field. This is because that there will be a resistive magnetic force acting on the left edge of the loop, and this occurs over a distance of L, the length of each side of the square loop.

Hence, total work done against resistive force,

$$\begin{aligned} W &= F_B L \\ &= (BI_{\text{induced}}L)(L) \\ &= B\left(\frac{E_{\text{induced}}}{R}\right)L^2 \\ &= B\left(\frac{BLv}{R}\right)L^2 \\ &= \frac{B^2L^3}{R}v \end{aligned}$$

where B is the flux density of the field, R is the resistance of each side of the wire.

Hence W is directly proportional to v.

Answer: B

23 Average e.m.f. induced,

$$\begin{aligned} E &= \left|-\frac{\Delta\Phi}{\Delta t}\right| \\ &= \frac{\Phi_f - \Phi_i}{\Delta t} \\ &= \frac{NBA\cos 0 - NBA\cos 45^\circ}{\Delta t} \\ &= \frac{3000\times 1.8\times \frac{\pi}{4}(0.020)^2}{0.060}(1-\cos 45^\circ) \\ &= 8.3\text{ V} \end{aligned}$$

Answer: A

24 When the current is flowing from X to Y, the effective resistance of the circuit is 2.0 Ω, and when the current is flowing from Y to X, the effective resistance of the circuit is 3.0 Ω.

Hence, the peak currents will be different when the current is flowing from X to Y and from Y to X.

Answer: D

25 Peak voltage in secondary coil is 90 V.
Resistor R_2 and R_3 are in parallel connection,
$\Rightarrow$ total resistance in circuit connected to the secondary coil is 120 Ω.

R.m.s. voltage in secondary coil, $V_{\text{r.m.s}} = \dfrac{90}{\sqrt{2}}$ V

R.m.s. current in secondary coil, $I_{\text{r.m.s}} = \dfrac{\frac{90}{\sqrt{2}}}{120}$ A

Average power dissipated in R_1
$= (I_{\text{r.m.s}})^2 \times 80$
$= 22.5$
≈ 23 W

Answer: B

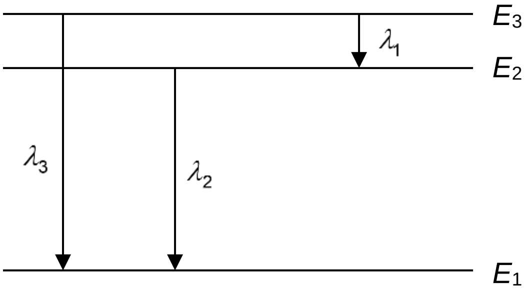
26 A and B seems to be the closest options. hf_o should be a form of energy rather than the threshold frequency.

Answer: A

27 Velocity decreases → de Broglie's wavelength increases → more diffracted → larger diameter of circles

Answer: A

28



$$E_3 - E_1 = \frac{hc}{\lambda_3} ------(1)$$

$$E_2 - E_1 = \frac{hc}{\lambda_2} ------(2)$$

$$E_3 - E_2 = \frac{hc}{\lambda_1} ------(3)$$

(1) – (2) – (3) = 0

$$\frac{hc}{\lambda_3} - \frac{hc}{\lambda_2} - \frac{hc}{\lambda_1} = 0$$

$$\frac{1}{\lambda_3} = \frac{1}{\lambda_2} + \frac{1}{\lambda_1}$$

Answer: B

29 A: Not true, mass-energy is conserved.
B: Not true, the larger nucleus has lower binding energy per nucleon, hence has lower binding energy.
C: True, from conservation of momentum, particles Y and Z has the same magnitude of momentum p. From $p^2 = 2mE$, KE is inversely proportional to mass.
D: Not true.

Answer: C

30 At time t, there are equal number of nuclides N_o of X and Y.

After one half-life, number of X nuclide $N_X = N_o/2$
number of Y nuclide $N_Y = N_o/2 + N_o = 3N_o/2$

i.e. the ratio of $N_X : N_Y = 1 : 3$

Answer: A