H2 PHYSICS

Exam papers with worked solutions
(Selected from Top JC)

SET A
PAPER 1
ANSWER

Compiled by

THE PHYSICS CAFE

1 D

$$\frac{\Delta z}{z} = \frac{\Delta(m_1 - m_2)}{(m_1 - m_2)} + \frac{\Delta I}{I} + \frac{\Delta t}{t}$$

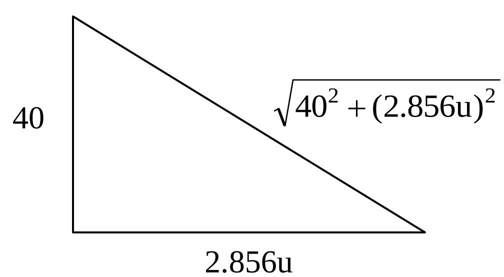
$$\frac{\Delta z}{z}\% = \left(\frac{2 \times 0.01}{(24.78 - 20.91)} + \frac{0.05}{3} + \frac{1}{7400}\right) \times 100\% = 2.2\%$$

2 C

For ping pong ball
Diameter = 4.0 cm; Radius = 2.0 cm
Vol of ping pong ball = $(4/3)(\pi)(0.02)^3 = 3.351 \times 10^{-5}$ m^3
Vol of classroom = 20 x 10 x 3.5 = 700 m^3
No. of ping pong balls = $(700) / (3.351 \times 10^{-5}) = 2.089 \times 10^7$

3 A

. $s = \frac{1}{2}at^2 \Rightarrow t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2(40)}{9.81}} = 2.856$ s



$$v_{sound} = 343 = \frac{\sqrt{40^2 + (2.856u)^2}}{(3.00 - 2.856)}$$

$$u = \frac{\sqrt{[(343)(3.00 - 2.856)]^2 - 40^2}}{2.856}$$

u = 10.2 m s^{-1}

4 A

Taking the release point as y = 0 and the ground as represented by the dotted line on the graph, the displacement of the ball will decrease with time as it further bounces.

5 A

When block is released, extension of spring decreases, hence tension due to spring (towards the right) decreases.
Friction acting towards the left is constant.
Net force (ma = Tension – friction) is decreasing and *a* is decreasing.

When spring is compressed, there is no force of compression. Hence net force on spring is only due to friction towards the left, so *a* is constant and negative.

6 **A**

Action-reaction pair of forces must not act on the same body.

Reaction force of weight is force by brick on Earth (both are non-contact forces)
Reaction force of normal contact force is force by brick on ground (both are contact forces)

7 **A**

The 3 forces acting on the rod is weight, *F* and the hinge force

For equilibrium, all 3 forces must pass through a common point, and the forces all point in a clockwise or anticlockwise manner

8 **B**

Balance reading
= Force by beaker on scale
= Force by scale on beaker (by N3L)
= Force by object on water + Weight of beaker of water (beaker is in equilibrium)
= Force by water on object (upthrust) + Weight of beaker of water
= *Z* + *X*

9 **B**

Total energy is conserved.
$2\ mgh = \frac{1}{2} mv^2$

10 **D**

work done = ke gained

11 **D**

$$F_d = 2F_w$$

$$\frac{mv_d^{\ 2}}{r} = 2\frac{mv_w^{\ 2}}{r}$$

Since $v_d = 16\ ms^{-1}$,

$$v_w = \sqrt{\frac{16^2}{2}} = 11\ ms^{-1}$$

12 **C**

$$\frac{Gm_1m}{r_1^{\ 2}} = \frac{Gm_2m}{r_2^{\ 2}}$$

$$\frac{r_1}{r_2} = \sqrt{\frac{m_1}{m_2}}$$

13 C

$$V \alpha \frac{1}{r} \Rightarrow \frac{V_s}{V_o} = \frac{2R}{R} \Rightarrow V_o = \frac{1}{2} V_s = -30\,\mathrm{MJ\,kg^{-1}}$$

Change in gravitational potential energy = ((-60) – (-30)) x 2000

= - 6 x 10^4 MJ = 6 x 10^{10} J

14 D

v = (dx)/dt so v-t graph is a negative cosine graph

15 B

Velocity of funnel is maximum at the equilibrium position, so sand cannot accumulate much at the centre. Velocity is zero at the amplitude positions, so sand accumulates at these extreme positions.

16 C

$$5 = \frac{mc\Delta\theta}{t} + \frac{h}{t} \quad \text{.......... (1)}$$

$$10 = \frac{3mc\Delta\theta}{t} + \frac{h}{t} \quad \text{.......... (2)}$$

3 x (1) – (2):

$$5 = \frac{2h}{t}$$

$$\frac{h}{t} = 2.5$$

17 D

Since gas is cooled → temp decrease → $\Delta U < 0$
Since temp decreases and pressure is kept constant → compression → $W > 0$

Thus by $\Delta U = Q + W$ → $Q < 0$

18 A

Let final temp of ice, water mixture be θ
Heat gain by ice = Heat loss by water

$$m_i l + m_i c_w(\theta - 0) = m_w c_w(100 - \theta)$$

$$m_i l + m_i c_w \theta = 100 m_w c_w - m_w c_w \theta$$

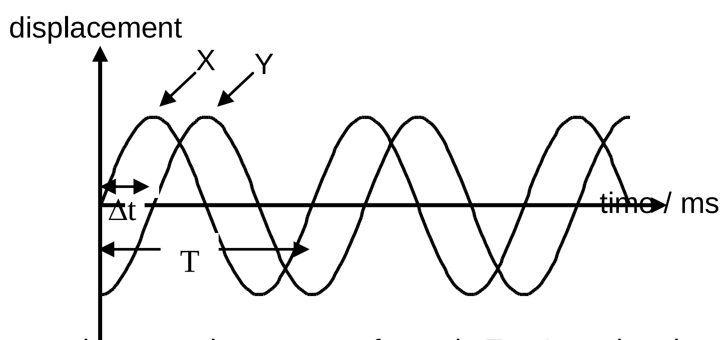
$$\theta(m_i c_w + m_w c_w) = 100 m_w c_w - m_i l$$

$$\theta = \frac{100 m_w c_w - m_i l}{(m_i c_w + m_w c_w)}$$

$$\theta = \frac{(100)(100)(4200) - (80)(340000)}{(80)(4200) + (100)(4200)} = 19.6^0 \mathrm{C}$$

Hence, answers B and C are out.
Since the ice will take time to melt completely, hence, A is the answer.

19 D



If the time difference between the two waveforms is T = 4 ms the phase difference is 2π
There if the time difference is Δt = 1 ms the phase difference is 1/4 x 2π = π/2.
From graph, X is leading Y by a time of 1 ms or phase of π/2

20 A

21 B

Both fixed ends must be nodes so possible resonant frequencies are as shown:

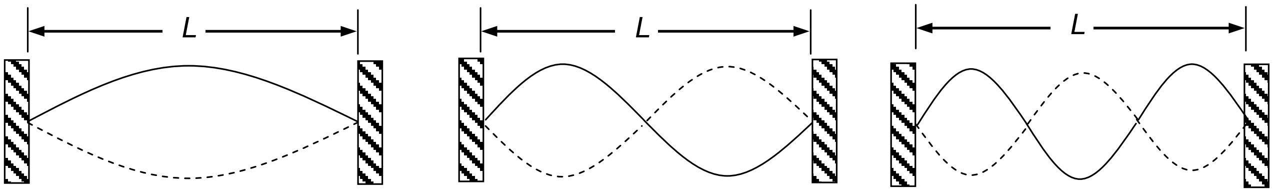


Fig 1 Fig 2 Fig 3

For Fig 1, the wavelength is $\lambda_1 = 2L$, Fig 2 , $\lambda_2 = L$ and Fig 3 $\lambda_3 = 2L/3$

Frequency $f = c/\lambda \Rightarrow f_1 = c/2L \;\; f_2 = c/L \;\; f_3 = 3c/2L$ ………

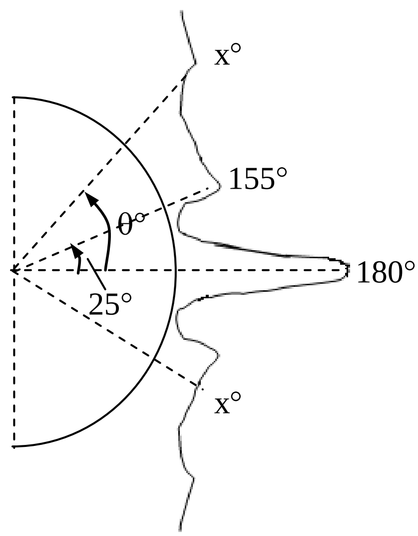
or $f_1 = c/2L \;\; f_2 = 2c/2L \;\; f_3 = 3c/2L$ ………

or $f = nc/2L$ where n = 1, 2,3,…….

22 C

$x = \lambda L / d \Rightarrow x = cL / fd$

23 D



Use $d \sin \theta = n\lambda$
Since d and λ are constant for the equation, $\sin\theta / \sin 25 = 2$
Therefore $\theta = \sin^{-1}(2 \sin 25) = 57.7°$
$x° = 180 - 57.7 = 122°$ or $x° = 180 + 57.7 = 238°$

24 A

Use $E = \dfrac{Q}{4\pi\varepsilon_o r^2}$ and consider direction of separate contributions to E.

To have X (where E=0) between the 2 charges, both charges must be of the same sign.

X must be closer to the smaller charge $\Rightarrow$ smaller r.

25 **B**

Use $V = \frac{Q}{4\pi\varepsilon_o r}$

V_{total} at centre of square = $2\left[\frac{-2Q}{4\pi\varepsilon_o(\frac{\sqrt{2}}{2}a)}\right] + 2\left[\frac{Q}{4\pi\varepsilon_o(\frac{\sqrt{2}}{2}a)}\right]$ (by scalar addition)

$= -\frac{\sqrt{2}Q}{2\pi\varepsilon_o a}$

Work done = q V_{total} = $-\frac{\sqrt{2}Q}{2\pi\varepsilon_o a}$

26 **D**

Initially qE=mg where $E = \frac{V}{d}$

After adding extra –ve charge, (2q)E > mg

To achieve equilibrium again, E must decreases → V deceases and d increases

27 **C**

High resistance voltmeter takes negligible current.

Terminal pd $V = E - Ir = E - \frac{E}{r+R}r = 15 - \frac{15}{4+2} \times 2 = 10$ V

Or

V = (15/4+2) × 4 = 10 V

28 **C**

Method I	Method II
$\frac{R_{PS}}{R_{PS}+R_{SQ}} V_{PQ} = V_{PS}$ $V_{PQ} = \frac{R_{PS}+R_{SQ}}{R_{PS}} V_{PS}$ $V_{PQ} = \frac{10}{0.65 \times 10}(15 \times 10^{-3}) = 0.023$ $V_R = 1.5 - V_{PQ} = 1.5 - 0.023 = 1.477$ $I = \frac{V_{PQ}}{R_{PS}+R_{SQ}} = \frac{0.023}{10} = 2.3 \times 10^{-3}$ $R = \frac{V_R}{I} = \frac{1.477}{2.3 \times 10^{-3}} = 642\ \Omega$	$V \propto \ell$ $\frac{V_{PS}}{V_{PQ}} = \frac{\ell_{PS}}{\ell_{PQ}}$ $\frac{15 \times 10^{-3}}{V_{PQ}} = \frac{0.650}{1}$ V_{PQ} = 0.023 V_R = 1.5 – 0.023 = 1.477 Same current $\Rightarrow V \propto R$ $\frac{V_R}{V_{PQ}} = \frac{R}{R_{PQ}}$ $\frac{1.477}{0.023} = \frac{R}{10} \Rightarrow R = 642\ \Omega$

29 A

30 A

Magnetic flux density B remains the same
Magnetic flux $\phi = BA = B(\pi r^2)$
New flux = $B(\pi(0.5r)^2) = 4\ B(\pi r^2) = 1/4\phi$

31 D

Force due to E-field = qE
Force due to magnetic field = Bqv

For ions to pass through undeflected and pass through all 3 slits,
qE = Bqv, hence v = E/B

E and B can be adjusted to select ions of particular v

32 A

Mean Power = I_{rms}^2 R = ($I_o^2/2$)R = 12.5 x 10 = 125 W

33 B

Intensity ↓, number of electrons emitted per second ↓, but no effect on max energy.

34 D

Let λ be wavelength of the other spectral line.
$E_3 - E_1 = hc/\lambda_1$
$E_3 - E_2 = hc/\lambda_2$
Hence $E_2 - E_1 = hc/\lambda_1 - hc/\lambda_2 = hc/\lambda$
$\therefore \lambda = \dfrac{\lambda_1\lambda_2}{\lambda_2 - \lambda_1}$

35 C

$eV = hc/\lambda_{min}$

36 D Spontaneous emission is also present.

37 C At the depletion region, the potential on the n-type side is higher than that on the p-type side.

38 D

39 C

40 A

When 7/8 has decayed, 1/8 has remained thus 1/8 = $(1/2)^3$, 3 half life of X has passed.
When ¾ has decayed, ¼ has remained thus ¼ = $(1/2)^2$, 2 half life of Y has passed

Thus $\frac{\text{half life of X}}{\text{half life of Y}}$ = 2/3