Answers to 2013 JC2 Preliminary Examination Paper 1 (H2 Physics)

1 D	**6 C**	**11 C**	**16 D**	**21 B**	**26 A**	**31 C**	**36 D**
2 B	**7 B**	**12 A**	**17 A**	**22 D**	**27 D**	**32 C**	**37 B**
3 B	**8 A**	**13 D**	**18 D**	**23 B**	**28 B**	**33 C**	**38 D**
4 B	**9 B**	**14 B**	**19 D**	**24 A**	**29 B**	**34 C**	**39 D**
5 D	**10 B**	**15 C**	**20 B**	**25 D**	**30 D**	**35 A**	**40 C**

1 Since $B = \dfrac{F}{IL}$,

units of B = units of $\dfrac{F}{IL}$

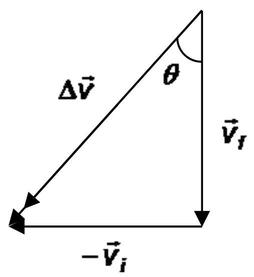
$= \dfrac{\text{kg m s}^{-2}}{\text{A m}}$

$= \text{kg s}^{-2}\,\text{A}^{-1}$

Answer: D

2 $\Delta\vec{v} = \vec{v}_f - \vec{v}_i$

$\Delta\vec{v} = \vec{v}_f + \left(-\vec{v}_i\right)$



$(\Delta v)^2 = (v_f)^2 + (v_i)^2$

$\Delta v = \sqrt{(7)^2 + (5)^2}$

$\Delta v \approx 9\ \text{m s}^{-1}$

$\tan\theta = \dfrac{v_i}{v_f}$

$\tan\theta = \dfrac{5}{7}$

$\theta \approx 36°$

Answer: B

3 The acceleration-time graph is obtained from the velocity-time graph. Point Q is the turning point of the velocity-time graph and so is the maximum value.

Answer: B

4 Let the initial speed of the javelin be u.

At the initial point, K.E. $= \frac{1}{2}mu^2 = E$

At the maximum height, K.E.' $= \frac{1}{2}m\left(u\cos 60°\right)^2$

$$= \frac{1}{4}\left(\frac{1}{2}mu^2\right)$$

$$= \frac{1}{4}E$$

Answer: B

5 Only D is the correct answer because it is moving at constant velocity. Resultant force zero.

Answer: D

6 Rate of change of momentum of the water = $\frac{m}{t}\Delta v$ =1.0 × 8.0 = 8.0 kg m s^{-1}.

From Newton's second law of motion, force on the water = 8.0 N
From Newton's third law, force on the notice-board = –8.0 N.
Hence magnitude of acceleration of the notice-board = $\frac{F}{m} = \frac{8.0}{2.0}$ = 4.0 m s^{-2}.

Answer: C

7 Upthrust on cargo = weight of sea- water displaced due to cargo = weight of cargo
Depth sank due to cargo(Δh) × cross-section of barge(A) × density of sea-water(ρ)× g = mg

$\Delta h = \frac{m}{A\rho} = \frac{2.0 \times 10^4}{97 \times 1030}$ = 0.20 m = 20 cm

Depth of bottom below surface is 70 – 20 = 50 cm

Answer: B

8 Extension, e = 90 – 60 = 30 mm
Tension = $k\,e$ = 500 × 0.030 = 15 N

Answer: A

9 lost in kinetic energy = work done against resistive force in the plank

$\Rightarrow \dfrac{1}{2}m[(150)^2 - (125)^2] =$ work done against friction

For the second bullet, the work done against friction stays the same when it passes through the plank.

$\Rightarrow \dfrac{1}{2}m[(150)^2 - (125)^2] = \dfrac{1}{2}m[(90)^2 - (v)^2]$

$\Rightarrow v = 35 \text{ m s}^{-1}$

Answer: B

10 Work done (WD) by applied force = (80)(3) = 240 J

WD against frictional force = friction × distance moved = (30)(3) = 90 J = heat generated.

Gained in gravitational potential energy = mgh = (40)(3.0 sin 30°)= 60 J

Using conservation of energy,

Gained in K.E. = 240 – 90 – 60 = 90 J

Answer: B

11 Since mass, radius and speed is the same, then the magnitude of the centripetal force on P and Q is the same, regardless of orientation. Centripetal force is provided by the net force towards the centre of the circular path and thus the net forces of P and Q are equal in magnitude.

Answer: C

12 For mass m_1:

$$\frac{m_1 v^2}{L+e} = ke$$

$$v^2 = \frac{ke(L+e)}{m_1}$$

For mass m_2:

$$\frac{m_2 v^2}{2(L+e)} = k(2L+2e-L)$$

$$\frac{m_2 v^2}{2(L+e)} = k(L+2e)$$

$$m_2 = \frac{2k(L+2e)(L+e)}{v^2}$$

$$= \frac{2k(L+2e)(L+e)m_1}{\mathrm{k}e(L+e)}$$

$$= \frac{2m_1(L+2e)}{e}$$

Answer: A

13 $F = \dfrac{GMm}{(R+h)^2}$

where $R =$ radius of Earth
$h =$ height of mountain

The height of the mountain is much smaller compared to radius of Earth. Even if the object is taken to another mountain with twice the original elevation, this will not significantly reduce the gravitational force acting on it.

Answer: D

14 $g_E = \dfrac{GM_E}{{r_E}^2} = 9.81\ \text{Nkg}^{-1}$

$g_V = \dfrac{GM_V}{{r_V}^2}$

$= \dfrac{G(0.8)M_E}{(0.9r_E)^2}$

$= 9.7\ \text{Nkg}^{-1}$

Answer: B

15 The potential energy of the oscillator is <u>maximum</u> when the oscillator is momentarily at rest.

Answer: C

16 $25 = 50 \sin \dfrac{2\pi t}{2}$

$t = \dfrac{1}{6}$ s

Hence it remained closed for $1\dfrac{5}{6}$ s.

Answer: D

17 Applying conservation of energy,
heat lost by aluminium block = heat gained by ice + heat gained by water and melted ice + heat gained by calorimeter
$(0.100)(924)(95) = m(3.36 \times 10^5) + (0.095)(4200)(5) + (0.05)(924)(5)$
$\Rightarrow m = 0.0195$ kg

Answer: A

18 mean translational k.e. per gas molecule = $\dfrac{3}{2}kT$ and is independent of mass.

Answer: D

19 Absolute temperature scale does not depend on the property of any particular substance.

Answer: D

20 For the first tuning fork:

$$L = \frac{\lambda}{4}$$
$$340 = 850\lambda$$
$$340 = 850(4L)$$
$$L = 0.100\,\text{m}$$

For the second tuning fork:

$$2L = \frac{\lambda_{\text{second}}}{4}$$
$$\lambda_{\text{second}} = 8L$$
$$340 = f\lambda_{\text{second}}$$
$$340 = f(8L)$$
$$340 = f(0.8)$$
$$f = 425\,\text{Hz}$$

Answer: B

21 $d\sin\theta = n\lambda$

$d\sin 40° = 3\lambda$

$$\frac{d}{\lambda} = \frac{3}{\sin 40°}$$

Since $\text{n} = \dfrac{d\sin\theta}{\lambda}$

Maximum value for $n = \dfrac{d}{\lambda}$

$$= \frac{3}{\sin 40°}$$
$$= 4$$

Answer: B

22 All statements are correct except D.

The magnitude of the force exerted on the ion, $F_E = qE$

$F_E = 4.8 \times 10^{-19} \times 4200 = 2.0 \times 10^{-15}$ N

Answer: D

23 When a positive charge is moved in the direction as the electric field, it will lose electric potential energy. Hence negative work is done on the charge.

W.D. on charge = electric force $\times$ distance
$= -qE \times$ distance
$= -2.6 \times 10^{-8} \times 300000 \times 4.0 \times 10^{-3}$
$= -3.1 \times 10^{-5}$ J

Answer: B

24 Option A: Correct. Because when connected in series to a battery, a common current passes through both X and Y, power = I^2R, so $P_x = 2 \times P_y$.

Option B: Incorrect. Since wires X and Y are made from the same material, they have the same resistivity.

Option C: Incorrect. Because when connected in parallel to a battery, a common p.d. is experienced by both X and Y, current in X = $\frac{1}{2} \times$current of Y.

Option D: Incorrect. Since $R = \frac{\rho l}{A}$, cross-sectional area of X = $\frac{1}{2}$cross-sectional area of Y, for the same length of the two wires.

Answer: A

25 Option A: Incorrect. $R_{XY} = 0.85R$.
Option B: Incorrect. $R_{XY} = 0.92R$.
Option C: Incorrect. $R_{XY} = 1.25R$.
Option D: Correct. $R_{XY} = 1.33R$.

Answer: D

26 The largest reading on the ammeter means largest current passing through it. Ammeter has a resistance of 2 Ω.

Consider p.d. across PQ = V

Option A: Correct. Current passing through ammeter, $I = \frac{V}{2}$, because ammeter is in parallel connection with the 1 Ω and 2 Ω resistors.

Option B: Incorrect. Current passing through ammeter, $I = \frac{V}{2.67}$.

Option C: Incorrect. Current passing through ammeter, $I = \frac{V}{5}$.

Option D: Incorrect. Current passing through ammeter, $I = \frac{V}{3}$.

Answer: A

27 The electric field will cause the electrons to experience a force towards the left. The magnetic field will cause the electrons to experience a force downwards. Since the magnitude of the two forces is the same, the beam of electrons will be deflected as shown in option D.

Answer: D

28 When the current in P increases, the magnetic forces of repulsion increase, but are the same on both P and Q. Given that the masses are the same, the angle of deflection will be the same for both, with only an increase in magnitude.

Answer: B

29 When the switch is closed, there is a change in magnetic flux through the ring. By Faraday's law, an e.m.f. is induced in the ring. By Lenz's law, the direction of induced current is such that it opposes the change in magnetic flux causing it. Hence, the induced current in the ring causes the ring to move away from the solenoid.

Answer: B

30 For the magnet to fall slower, the induced upward magnetic force on the magnet has to increase, or the resultant downward force on the magnet has to decrease.

Option A: Releasing the magnet from a smaller height will cause the rate of change of magnetic flux through the pipe to decrease since the magnet enters the pipe with a lower speed. Hence, the induced e.m.f. in the pipe will be of a smaller value, which will result in a smaller current and induced magnetic force.
Option B: A pipe with a higher resistivity will cause the induced current to be of a smaller value, which will result in a smaller induced magnetic force.
Option C: A weaker magnet will cause the induced e.m.f. to be of a smaller value, since the rate of change of magnetic flux through the pipe will decrease.
Option D: The induced magnetic force is the same and the resultant downward force will decrease due to the smaller weight of the magnet.

Answer: D

31 $I_{\text{RMS}} = \sqrt{\dfrac{2^2 \times \dfrac{T}{2} + 1^2 \times \dfrac{T}{2}}{T}} = 1.58\text{ A}$

$\langle P \rangle = I_{\text{RMS}}^2 \times R = 1.58^2 \times 100 = 250\text{ W}$

Answer: C

32 For 100 % efficiency,

$$\frac{I_s}{I_p} = \frac{N_p}{N_s}$$

$$I_s = \frac{N_p}{N_s} \times I_p = \frac{1200}{500} \times 0.25 = 0.60 \text{ A}$$

For 83 % efficiency,

$$I_s = 0.83 \times 0.60 = 0.50 \text{ A}$$

Answer: C

33 Having the wavelength and frequency constant would mean that the energy of the photon remains constant ($E = hf$). The most energetic electron would have the same KE as before; hence the stopping potential is unchanged. However, halving the intensity of radiation will halved the photocurrent as the rate of emission of photoelectron is halved.

Answer: C

34 As photon passes through the glass, its speed decreases. This decrease is due to its wavelength decrease, while the frequency remains the same. Since the energy of the photon depends on frequency, energy remains constant.

Answer: C

35 The potential energy gained by the electron = $qV = 3.20 \times 10^{-15}$ J

$$\frac{hc}{\lambda} = 3.20 \times 10^{-15} \text{ J}$$

$$\lambda = 6.22 \times 10^{-11} \text{ m}$$

Answer: A

36 When atoms are close together, there are mutual interactions amongst the atoms and bands are formed.

Answer: D

37 The atoms in an intrinsic semiconductor are neutral. When electrons move from the valence band to the conduction band, the number of holes created is equal to the number of electrons.

Answer: B

38 There would be diffraction since the slits through which the laser come out are narrow.

Answer: D

39 $\text{Energy released} = (121 \times 8.26) + (113 \times 8.52) - (235 \times 7.59) \approx 179 \text{ MeV}$

Answer: D

40 By conservation of momentum, $m_1 v_1 = m_2 v_2$

$$\Rightarrow \frac{v_1}{v_2} = \frac{m_2}{m_1} \quad .... (1)$$

Energy of m_1 , $E_1 = \frac{1}{2} m_1 v_1^2$ .... (2)

Energy of m_2 , $E_2 = \frac{1}{2} m_2 v_2^2$ .... (3)

$E = E_1 + E_2$

$$\frac{(2)}{(3)}: \quad \frac{E_1}{E_2} = \frac{m_1 v_1^2}{m_2 v_2^2} = \frac{m_2}{m_1}$$

$$\Rightarrow \frac{E_1}{E - E_1} = \frac{m_2}{m_1}$$

$$\Rightarrow E_1 = \frac{m_2}{m_1 + m_2} E$$

Answer: C