2014 VJC Prelim H2 Paper 1 *Suggested Solutions*

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

1. **Ans: B**
Option A gives a radius of 6 cm
Option B gives a radius of 13 cm
Option C gives a radius of 29 cm
Option D gives a radius of 62 cm
So B is the most sensible answer.

2. **Ans: C**
F = ma
a= F/m
$$\Delta a = a\left(\frac{\Delta F}{F} + \frac{\Delta m}{m}\right) = 0.67\left(\frac{0.1}{2.0} + \frac{0.05}{3.00}\right) = 0.04 \text{ m s}^{-2}$$

3. **Ans: D**
At maximum height, $v_y = 0$ while $v_x = v\cos\theta$
$\therefore$ k.e. at maximum height = $m(v\cos\theta)^2/2$
= $\text{k.e.}_{\text{initial}} \cos^2\theta$
= $15 \cos^2 30^o$
= 11 J

4. **Ans: C**
Car B catches up with car A when both travel the same distance. So find the time when this happens.
At t = 5.0 s:
Distance travelled by Car A = area under car A's graph = 0.5 x 5.0 x 5.0 = 12.5 m
Distance travelled by car B = 0.5 x 3.0 x 7.5 = 11.25 m

So after t = 5.0 s, car B must travel 12.5 – 11.25 = 1.25 m more than car A.
Time needed to do this = 1.25/(7.5 – 5.0) = 0.5 s
So car B catches up with car A at t = 5.0 + 0.5 = 5.5 s

5. **Ans: D**
By N3L, the action and reaction pair is equal in magnitude.

6. **Ans: B**

Change in momentum,

$$\Delta p = Area\ under\ F - t\ graph = \frac{1}{2}(2x3) + (2\times 3) = 9.0\,kg\,m\,s^{-1}$$

$$Final\,velocity,\ v = u + \frac{\Delta p}{m} = 2.0 + \frac{9.0}{2} = 6.5\,m\,s^{-1}$$

7. **Ans: A**

Total *clockwise* moments, $(20\times 3) = 60\,N\,m$

Total *anticlockwise* moments, $(5\times 2)+(10\times 2) = 30\,N\,m$

Resultant moments, $60 - 30 = 30\,N\,m$

8. **Ans: D**

For *equilibrium*, the *lines of action* of the three forces must pass through a common point.

9. **Ans: D**

Total mechanical energy is not constant as gravitational potential energy is used to do work against friction.

10. **Ans: B**

By Conservation of Energy, Elastic PE = ΔKE

$$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 \Rightarrow x \propto \left(\sqrt{m}\right)v \text{ since k is the same.}$$

$$\therefore \frac{x}{d} = \left(\sqrt{\frac{3m}{m}}\right)\frac{3v}{v} \Rightarrow x = \left(\sqrt{3}\right)3d = 5.2d$$

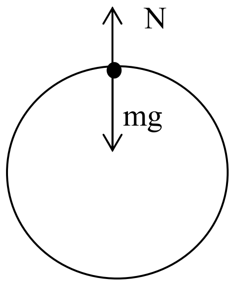
11. **Ans: B**

$mg - N = mv^2/r$

$N = m(g - v^2/r)$

$= 200(9.81 - 8.0^2/12)$

$= 895 \approx 900$ N



12. **Ans: A**

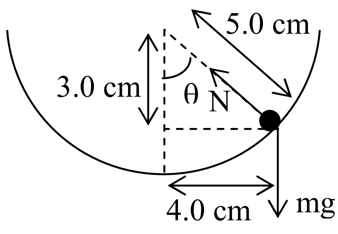
Horizontally, $N \sin\theta = m\omega^2 r$ (1)

Vertically, $N \cos\theta = mg$ (2)

(1)/(2) $\tan\theta = \omega^2 r/g$

$$\omega = 2\pi/T = \sqrt{\frac{g\tan\theta}{r}}$$

$$T = 2\pi\sqrt{\frac{r}{g\tan\theta}} = 2\pi\sqrt{\frac{0.040}{9.81\times\frac{4}{3}}} = 0.35 \text{ s}$$



13. **Ans: D**

$$\text{gravitational force on planet } F_G = \frac{GMm}{R^2}$$

$$\text{gravitational acceleration} = \frac{F_G}{m} = \frac{GM}{R^2}$$

14. **Ans: D**

There is only one force, the gravitational force F_G, exerted by the Earth on the satellite which provides the centripetal force required to maintain the satellite in orbit. The centripetal force is a resultant force and it should not be shown in the diagram.

15. **Ans: B**

Damping means that energy is lost from a system over time, regardless of whether that system is in a state of resonance or not.

16. **Ans: C**

$T = 0.63$

$\omega = 2\pi / T = 9.97 \text{ rad s}^{-1}$

$v_0 = \omega x_0$

$\therefore x_0 = 5.0 / 9.97 = 0.50 \text{ m}$

17. **Ans: B**

B, latent heat of vaporization is the energy required to overcome intermolecular forces (and hence potential energy) per unit mass of substance. The lower the temperature, the higher the intermolecular PE, the more energy must be delivered to overcome it.

18. **Ans: D**

$$KE_{gas} = \frac{3}{2} NkT$$

Hence an increase in T increases the KE and internal energy of the gas.
If pressure is constant,

$$PV = nRT$$

V must increase since T increases, hence work is done by the gas. Thus using the first law of thermodynamics, the heat supplied must be positive.

19. **Ans: B**

$\lambda = v/f = 2.4/1.6 = 1.5$ m

$$\phi = \frac{x}{\lambda} \times 2\pi$$

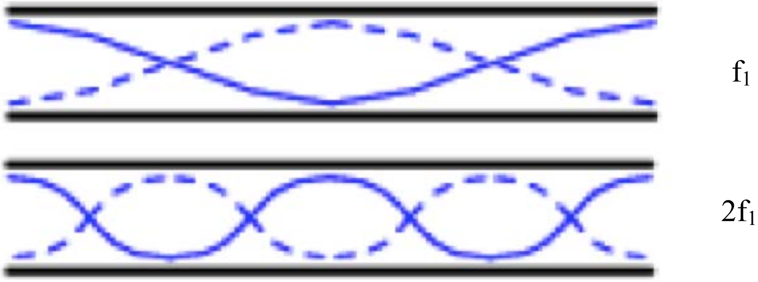
$$= \frac{0.50}{1.5} \times 2\pi = \frac{2\pi}{3} \text{ rad}$$

20. **Ans: D**

Option D is correct. Since all particles on the string are vibrating in SHM, at P and R the particles are at the maximum displacements and thus will have maximum accelerations.

Option A is wrong because S is at the eqm position and has maximum speed and thus higher speed than Q.
Option B is wrong because R is momentary at rest and hence not moving.
Option C is wrong because P has entirely potential energy, not ke.

21. **Ans: C**
By drawing the stationary waves that has twice the frequency of f_1, it can be counted that there are 5 antinodes.



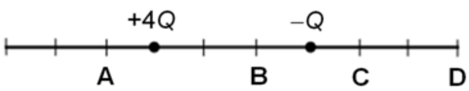
22. **Ans: B**
Waves from P has intensity I and amplitude A.
Waves from Q has intensity 4I and thus has amplitude 2A.

Path difference = PX – QX = 2.5 – 2.0 = 0.5 m
Since wavelength is 0.04 m, then the path difference = 0.5 /0.04 = 12.5λ.
Thus at point X the waves meet out of phase.
Resultant amplitude = 2A – A = A.
Hence resultant intensity = I.

23. **Ans: B**
For the droplet to be stationary, the weight of the droplet is equal in magnitude to the electric force exerted on the drop.

$$mg = qE$$
$$mg = q\left(\frac{2V}{d}\right)$$

24. **Ans: D**



At D, the resultant electric field due to the two charges,

$$E_R = \left(\frac{+4Q}{4\pi\varepsilon_0(6)^2}\right) + \left(\frac{-Q}{4\pi\varepsilon_0(3)^2}\right) = 0$$

25. **Ans: D**

Both the electrons and protons contribute to the current.

Total current $= \dfrac{\Delta Q}{\Delta t} = \dfrac{(n_{electron} + n_{proton})e}{1} = \left(5.0\times10^{18} + 2.0\times10^{18}\right)\left(1.60\times10^{-19}\right)$

$= 1.1$ A

26. **Ans: B**

Note that 5.0 kV is the transmission voltage, and NOT the p.d. across the cables (which is 100 V).

The current flowing through the cables, $I = P/V = 100/5 = 20$ A

The power dissipated in the cables = $I^2R = (20)^2(5) = 2000$ W

27. **Ans: C**

When R decreases, the total resistance of the entire circuit decreases. Since the emf remains constant, the total current I_{total} increases. ($I_{total} = I_1 + I_2$)

Because the current (I_{total}) flowing through R_1 increases, the p.d. across R_1 increases. This means that the p.d. across R_2 decreases, and that I_1 decreases.

Since I_{total} increases and I_1 decreases, then I_2 must increase.

28. **Ans: C**

Apply $E = I(R + r) = V + Ir$

Rearranging gives : $V = -Ir + E$

Based on this linear equation, the V-axis intercept gives the emf. So, the emf, $E = 6.0$ V.

The magnitude of the gradient gives the internal resistance, so $r = 6/4 = 1.5\ \Omega$.

29. **Ans: C**

In (a) when both B- and E-fields are switch on, the charge goes thru undeflected, ie.

$F_E = F_B$

$qE = qvB$

$\Rightarrow \quad v = E/B \qquad$ - - - - (1)

In (b), the E-field is switched off. The charge will undergo circular motion, ie.

$$\frac{mv^2}{r} = Bqv$$

$$m = \frac{Bqr}{v}$$

From (1), v = E/B, hence

$$m = \frac{Bqr}{E/B} = \frac{B^2qr}{E}$$

30. **Ans: A**
The current flowing in the solenoid A sets up a magnetic field with a S pole at its right-end. As A moves with constant speed away from B, the magnetic flux set up by A linking B decreases, and the induced emf in B and hence induced current decreases. This induced current will flow from Q to P to set up a N pole at the left end of the solenoid B to attract the receding S pole of the solenoid A.

31. **Ans: A**
In A, there is maximum flux linkage with the area of the coil. As the alternating current changes direction, the rate of change of flux linkage will be a maximum giving a maximum induced emf.

32. **Ans: B**

$$V = 2.0 \times 3\ \text{cm} = 6.0\ \text{V}$$

$$f = \frac{1}{T} = \frac{1}{(20 \times 10^{-6} \times 8\ \text{cm})} = 6250\ \text{Hz}$$

33. **Ans: C**

$$\frac{V_{rms}{}^{2}}{R_{lamp}} = P$$

$$R_{lamp} = \frac{V_{rms}{}^{2}}{P} = \frac{(V/\sqrt{2})^{2}}{P} = \frac{(180/\sqrt{2})^{2}}{50} = 324\ \Omega$$

$$P' = \frac{V'_{rms}{}^{2}}{R_{total}} = \frac{180^{2}}{324 + 324} = 81.6\ \text{W}$$

34. **Ans: B**

When the frequency of light increases, each photon carries more energy. However, since the intensity remains constant, the total energy of the light wave per unit time is constant. Thus there must be fewer photons and hence fewer photoelectros produced. Thus the current must fall.
Since the energy per photon is now higher, the photoelectrons emerge with a larger KE. Thus a larger stopping potential is needed to have zero photocurrent.

35. **Ans: D**
Line emission spectrum has lines whose frequencies match a transition between such discrete energy levels in an atom.

36. **Ans: A**
The deceleration of electrons produce electromagnetic waves, in this case, X rays.

37. **Ans: A**
refer to lecture notes

38. **Ans: D**
refer to lecture notes

39. **Ans: C**
"A" is wrong. For nuclei with low nucleon numbers, energy will be released when they undergo fusion (not fission) with other low-mass nuclei.
"B" is wrong. For nuclei with very high nucleon numbers, energy will be released when they undergo fission (not fusion).
"D" is wrong because $^{238}_{92}U$ is not a stable end-product of any radioactive series. Its binding energy per nucleon is comparatively low for a high-mass nuclide, so it may fission into products with higher binding energies per nucleon.
"C" is correct. $^{27}_{13}Al$ has a higher binding energy per nucleon than $^{23}_{11}Na$, so $^{27}_{13}Al$ can be regarded as being more stable than $^{23}_{11}Na$. $^{27}_{13}Al$ will not "spontaneously" decay to become $^{23}_{11}Na$.

40. **Ans: B**
Initial activity of alpha emitter = 160 – 96 = 64 Bq
After 12 days (= 3 half-lives):
Activity of alpha source = 64/8 = 8 Bq

Initial activity of beta emitter = 96 Bq
After 12 days (= 4 half-lives):
Activity of beta source = 96/16 = 6 Bq

Hence, total activity after 12 days = 8 + 6 = 14 Bq