2014 VJC Prelim H1 Paper 1 *Suggested Solutions*

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

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: B**
   $\mu_0 = B/nI$
   F = BIL
   B= F/IL
   Units of B = $\frac{kg\ m}{s^2}\times\frac{1}{A}\times\frac{1}{m} = \frac{kg}{s^2}\times\frac{1}{A}$
   Units of μ_0 = $\frac{kg}{s^2}\times\frac{1}{A}\times m\times\frac{1}{A} = \frac{kg\ m}{s^2A^2}$

3. **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 m s^{-2}

4. **Ans: B**
   Since the ball is dropped, it should start with zero speed.
   The gradient of the graph gives the acceleration due to free fall.

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

6. **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

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

8. **Ans: B**
Change in momentum,

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

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

9. **Ans: B**
Applying N2L, $F = v\dfrac{dm}{dt} = 0.8\times 12 = 9.6\,N$

10. **Ans: A**
Total *clockwise* moments, $(20\times 3) = 60N\,m$
Total *anticlockwise* moments, $(5\times 2) + (10\times 2) = 30N\,m$
Resultant moments, $60 - 30 = 30N\,m$

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

12. **Ans: D**
Total mechanical energy is not constant as gravitational potential energy is used to do work against friction.

13. **Ans: B**
By Conservation of Energy, Elastic PE = ΔKE

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

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

14. **Ans: A**
Energy needed to lift the passengers = mgh
= 10 x 60 x 9.81 x 5 = 29.4 kJ
Work done against friction = F.d = 1.4 x 10^3 x (5 / sin 30°) = 14 kJ
Efficiency = 29.4 / (29.4 + 14) x 100 % = 68 %

15. **Ans: B**

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

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

16. **Ans: C**

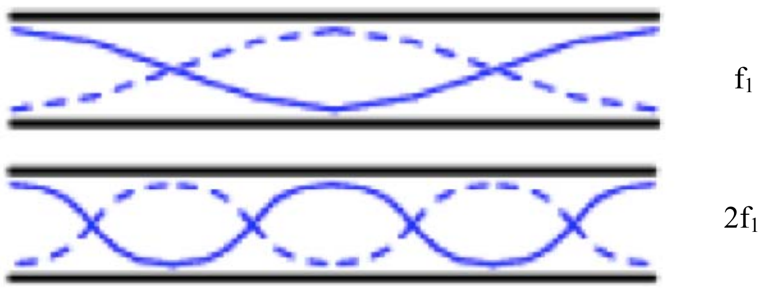
Option C is not true since EM waves only travel at 3.0 x 10^8 m s^{-1} when in vacuum, and the speed slows down when the waves enter into a medium.

17. **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 equilibrium 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.

18. **Ans: C**

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



19. **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.

20. **Ans: B**

$$\Delta x = \frac{\lambda D}{d}$$

$$d = \lambda \frac{D}{\Delta x}$$

Since the fringes are very closes spaced, the angular separation θ between the fringes can be given by:

$$\theta = \frac{\Delta x}{D} = 4.00 \times 10^{4} \text{ rad}$$

Hence

$$d = \lambda \frac{D}{\Delta x}$$

$$= \frac{4.0 \times 10^{-7}}{4.00 \times 10^{-4}} = 1.0 \times 10^{-3}$$

21. **Ans: D**

Both the electrons and protons contribute to the current.

$$\text{Total current} = \frac{\Delta Q}{\Delta t} = \frac{(n_{electron} + n_{proton})e}{1} = (5.0 \times 10^{18} + 2.0 \times 10^{18})(1.60 \times 10^{-19})$$

= 1.1 A

22. **Ans: C**

At about $V = +0.7$ V, the current surges very quickly. This suggests that a diode is responsible for this special behaviour. The light bulbs in "B" and "D" cannot explain this surge in current.

When V is negative, and becoming increasingly negative, the magnitude of the current still rises proportionally. This rules out "A" because the single diode will not allow any current to flow under reverse-bias. "C" can explain the graph because the resistor (connected in parallel to the diode) will still allow current to flow even when the diode is connected in a reverse-bias manner.

23. **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

24. **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.

25. **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 $r = 6/4 = 1.5\ \Omega$.

26. **Ans: B**
Since θ is the angle between the current and the B-field, then $F = BIL \sin\theta$
Hence $F \propto \sin\theta$ as θ is being varied with B, I and L held constant.

27. **Ans: A**
Current I_1 in coil P will produce magnetic fields directed vertically upwards at the centre of the coil.
By Fleming's Left hand rule, there will be a force acting on current I_2 in the rod, in the direction TS. Hence the rod will accelerate towards TS.

28. **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.

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

30. **Ans: A**
Transitions between E_3 to E_2, E_3 to E_1 and E_2 to E_1.