Solutions to SJPO 2009 Special Round

1(a) $18.3mm$

1(b) $14.3mm$

1(c) $8.6mm$

2 $M_2 = 10kg$
$M_1 = 20kg$

shorter time for the wave to travel from one mass to the other.

3 Distance $= \dfrac{893+5t}{60000}$ (m)

4(a) 6.4m

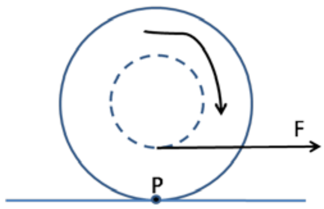
4(b) $0.49kg$

5(a) $\left(1-\dfrac{\sqrt{5}}{5}\right)H$

5(b) $\dfrac{2\sqrt{5}-1}{10}H$

6 The laser beam does not blast the Goth, but is fired at 667m in front of the ship's nose in Goth's frame of reference. Events of passing each other (Hun's ship nose meeting Goth's ship tail) and laser firing is simultaneous in Hun's frame but not in Goth's frame.

7(a) Taking moments about point P, there is clockwise moment acting on the yo-yo. Hence the yo-yo will roll forward (right).



7(b)(i) $Fr = FR\cos\theta \Rightarrow \cos\theta = \dfrac{r}{R}$

7(b)(ii) $F = \dfrac{\mu Mg}{\mu\sin\theta + \cos\theta}$

8(a) $\theta_2 = 60.3°$

8(b) $221°C$

9 $\quad \dfrac{Q_1}{Q_2} = \dfrac{1}{2\sqrt{2}}$

10(a)(i) R

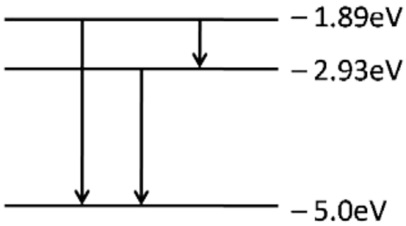
10(a)(ii) $R(\sqrt{3}+1)$

10(b) $\quad \dfrac{\sqrt{2}}{2}\rho d$

10(c) $\quad V_2 = 4.5V$ (assuming the battery has no internal resistance)

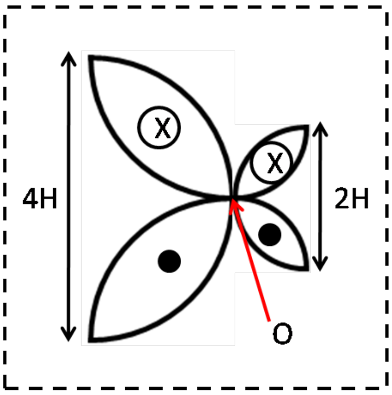
11(a) $\quad 2.1eV$

11(b) $\quad \lambda = 1.2\mu m$



This radiation is infrared radiation, which cannot be observed by human eye as it is not in the visible range.

12 The magnetic field pattern is as shown at the right.



For the top left region, the electrons have to bend downwards. By Fleming's Left Hand Rule, the magnetic field will point into the page of paper. For bottom left region, the electrons have to bend upwards, by the same rule again, the magnetic field will point out of the page of the paper. The directions for the right regions are determined with the similar manner.

For the top left region, the radius of curvature of outermost arc is $2H$, using $evB = \dfrac{mv^2}{2H}$, magnetic flux density applied, $B = \dfrac{mv}{2eH}$, similar to the outermost arc for bottom left region.

For the right region, the magnetic flux density applied for the outermost arc will be $B = \dfrac{mv}{eH}$

For the upper left region, the curve describing the bottom arc is $(R-y)^2 + x^2 = R^2$ where $R = 2H$; similar exercise can be done for other regions.