

1. The acceleration, $a = (24-4)/(7+3) = 2\text{m/s}^2$ (0.5 Mark)

Applying Newtons equation to any of the blocks will give $F=F' = 10\text{N}$ (0.5 Mark)

2. Pressure = $h\rho g = .07 \times 13600 \times 9.8 = 9330 \text{ Pa}$ (1 Mark)

Using the incorrect height will lead to a penalty of 0.5.

3. Both the bullets will hit the ground at the same time (0.7 Marks)

Since they are shot horizontally from the same height both undergo exactly same free fall (0.8 Marks)

4. $(1/4\pi\epsilon_0) qe/(12)^2 = mg$ (Gravity Balanced by electrostatic attraction) - 1Mark

Solving $q = (9.8 \times 9.1 \times 10^{-31} \times 144)/(1.6 \times 10^{-19} \times 9 \times 10^9) =$

5. When S is open , $I = 30/24 = 1.25 \text{ A}$ (1 Mark)

When S is closed , $I = 30/(12+6) = 1.67 \text{ A}$ (1 Mark)

6. While Falling for the first time the ball travels 8m. Between the first and second bounce it travels $2 [8^{3/4}] \text{ m}$. Between second and third bounce it travels $2 [8^{3/4}]^2 \text{ m}$ etc.

So the total distance travelled , $S = 8 + 16[3/4 + (3/4)^2 + (3/4)^3 + \dots] = 8 + 16 (3/4 / (1 - 3/4)) = 56\text{m}$

Missing the factor of 2 in between bounces will carry a penalty of .8 marks.

7. The height gained after the first bounce is $h' = 8(3/4) = 6 \text{ m}$.

Thus the associated KE is $mgh' = 1 \times 9.8 \times 6 = 58.8 \text{ J}$ (1 Mark – NO partial marks)

8. As $P = I^2R$ (while the resistance is held fixed) , doubling the current will lead to 4 fold increment of the power dissipated. (1 Mark – NO partial marks)

9. $t_1 + t_2 = 2.7\text{s}$

Free fall gives $h = \frac{1}{2}gt_1^2$ while sound propagation gives $h = 330t_2$.

So $\frac{1}{2}gt_1^2 = 330t_2$ (Setting up this equation deserves 1 mark)

Solving for t_1 and t_2 gives 2.6s and .1s respectively (.5 mark)

Using these $h = 33\text{m}$ (0.5 m)

10. None – as all are waves (1 mark – NO partial marks)

11. Refractive index of diamond = $1/\sin(24.4^\circ) = 2.42$ (0.5 Marks)

Refractive index of diamond wrt water = $2.42/(4/3) = 1.815$ (0.5 Marks)

Critical angle between water and diamond , = $\sin^{-1}(1/1.815) = 33.42$ degrees (0.5 Marks)

12. The angle of refraction = $\tan^{-1}(8/17) = 25.2$ degrees (1 Mark)

Refractive index = $\sin(40) / \sin(25.2) = 1.51$ (1 Mark)

13. The generated heat = $\frac{1}{2}(\frac{1}{2}mv^2) = 2000\text{J}$ (1 Marks)

Temperature rise = $2000 / (0.05 \times 390) = 102.6\text{K}$ (1 Marks)