2022 Year 5 July Physics Common Test Solutions

1 **C** Volume of average classroom = 8 × 8 × 3 = 192 m^3

2 **D**

$$s = ut + \frac{1}{2}at^2$$

$$h = \frac{1}{2}(9.81)t^2$$

$$\sqrt{h} = \left(\sqrt{\frac{1}{2}(9.81)}\right)t$$

From the positive x-intercept, it can be deduced that the ball was dropped consistently after the timing was started.

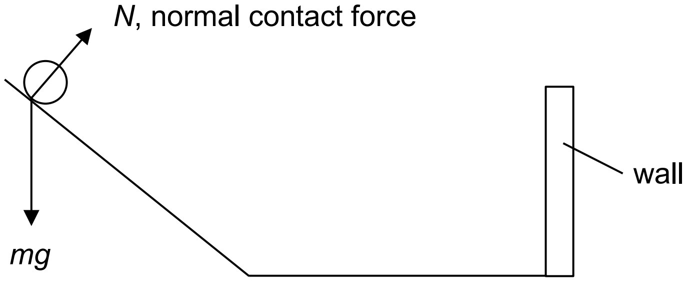
3 **C**

$$v_{avg} = \frac{\text{total distance}}{\text{total time}} = \frac{s+s}{\frac{s}{3.0}+\frac{s}{5.0}} = \frac{2s}{\frac{5.0s+3.0s}{15}} = 3.75 \text{ m s}^{-1}$$

4 **B** Since distance from Q to wall and wall to Q are the same, the positive area under the v–t graph should be the same as the negative area.

As collision is inelastic, the speed at which the ball rebounds should be lower which is represented by a lower negative v compared to the positive v just before it rebounds.

The diagram below shows the normal contact force N and weight acting on the ball. When the ball is travelling along the slope, the horizontal acceleration of the ball is due to the horizontal component of N.



Since the gradient of line when the ball moves along the slope in the v–t graph represents horizontal acceleration of the ball down, it should be the same gradient whether the ball moves down or up the slope since it experiences the same horizontal acceleration due to the horizontal component of N along the slope.

5 **D**

By Newton's 2nd Law, $F - f = 3ma \Rightarrow a = \frac{F-f}{3m}$

Applying Newton's 2nd Law again to the composite body of B and C,

$$F_{AB} = 2ma = 2m\left(\frac{F-f}{3m}\right) = \frac{2}{3}(F-f)$$

6 **A** 3kg mass: $3 \times 9.81 \sin 30^\circ - T = 3a$

1.4kg mass: $T - 1.4 \times 9.81 \sin 60^\circ = 1.4a$

Adding the two equations,

$$3 \times 9.81 \sin 30^\circ - 1.4 \times 9.81 \sin 60^\circ = 4.4a$$

$$a = 0.64 \text{ m s}^{-2}$$

7 **B** The weight of the satellite (i.e. the gravitational force exerted by the Earth on the satellite) serves as the centripetal force for the orbital motion of the satellite. The reaction force to the weight of the satellite is the gravitational force exerted by the satellite on the Earth.

8 **A** As the water surface rises, the pressure at both the top and the bottom of the container increases ($p = \rho g h$), so the spring is being compressed with an increasing force. Hence, the spring length will decrease.

Since the spring length decreases, the piston moves downward. The volume of the container, hence the weight of the liquid displaced, decreases. Hence, the upthrust acting on the container decreases. Since the total weight of the container and its content does not change, the tension in the string will decrease (upthrust = weight + tension).

9 **B** The three forces form a closed triangle in the head-to-tail fashion.

10 **C** Work done by spring = loss of GPE + loss of KE

$$\langle F \rangle \times y = mgh + \tfrac{1}{2} mv^2$$

$$\langle F \rangle \times (0.06) = (0.50)(9.81)(0.56) + \tfrac{1}{2}(0.50)(2.0)^2$$

$$\langle F \rangle = 62 \text{ N}$$

11 **C**

$$\text{efficiency} = \frac{\text{output power}}{\text{input power}} \times 100\%$$

$$0.30 = \frac{\dfrac{\frac{1}{2}(2)\left(14 \times \frac{1000}{3600}\right)^2}{3.0}}{\text{input power}}$$

$$\text{input power} = 17 \text{ W}$$

12 **D**

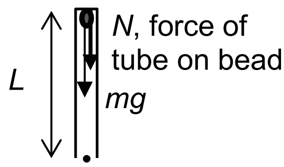
$$a = r\omega^2 \Rightarrow \frac{a_Q}{a_P} = \frac{r_Q}{r_P}\frac{\omega^2}{\omega^2} = \frac{r_Q}{r_P}$$

$$a_Q = \frac{r_Q}{r_P} \times a_P = \frac{4.0}{6.0} \times 54 = 36 \text{ cm s}^{-2}$$

13 **C**

$$mg + N = mr\omega^2 \Rightarrow mg + \frac{1}{2}mg = \frac{3}{2}mg = mL(2\pi f)^2$$

$$2\pi f = \sqrt{\frac{3g}{2L}} \Rightarrow f = \frac{1}{2\pi}\sqrt{\frac{3g}{2L}} = 0.61\sqrt{\frac{1}{L}}$$



14 A

$$g = \frac{GM}{R^2},\ \text{but } M = \text{Vol} \times \text{density} = \frac{4}{3}\pi R^3 \times \rho$$

$$\therefore g = \frac{G}{R^2}\left(\frac{4}{3}\pi R^2 \times \rho\right) = \frac{4}{3}\pi G R \rho$$

$$\therefore g = \frac{4}{3}\pi \times 6.67 \times 10^{-11} \times \frac{12100 \times 10^3}{2} \times 5240 = 8.86\ \text{m s}^{-2}$$

15 D

$$\text{gravitational field strength} = G\frac{3M}{d^2} - G\frac{M}{d^2} = \frac{2GM}{d^2}$$

$$\text{gravitational potential} = -G\frac{3M}{d} - G\frac{M}{d} = -\frac{4GM}{d}$$