Dunman High School **Year 5 Holiday Revision Set B** Answers

1 **(a)** Use $v^2 = u^2 + 2gs$

At highest point, $v = 0$

$$0 = (800 \sin \alpha)^2 - 2(9.81)s$$

$$\text{or } s = \frac{640000 \sin^2 \alpha}{2g} \quad \text{[A1]}$$

Minimum height = s + 300

$$= \frac{640000 \sin^2 \alpha}{2g} + 300 \quad \text{[A1]}$$

(b) Time of flight t is found using $v = u + gt$

$$-800 \sin \alpha = 800 \sin \alpha - gt$$

$$t = \frac{1600 \sin\alpha}{g} \quad \text{[A1]}$$

Use $x = ut = (800 \cos \alpha)\left(\frac{1600 \sin\alpha}{g}\right)$ [M1]

$$= \frac{(800)^2(2)(\sin\alpha)(\cos\alpha)}{g}$$

$$= \frac{640000(\sin 2\alpha)}{g} \quad \text{[A0]}$$

(c)(i) units of R = units of $E^{0.2} \rho^{-0.2} t^{z}$

m = (kg m^2 s^{-2})$^{0.2}$ (kg m^{-3})$^{-0.2}$ s^{z}

= m s$^{z-0.4}$ [M1]

$z = 0.4$ [A1]

(c)(ii) $R = E^{0.2} \rho^{-0.2} t^{0.4}$

$E = R^5 \rho t^{-2}$

$$\frac{\Delta E}{E} = 5\left(\frac{\Delta R}{R}\right) + \frac{\Delta \rho}{\rho} + 2\left(\frac{\Delta t}{t}\right) \quad \text{[M1]}$$

$$= 5\left(\frac{2}{80}\right) + \frac{0.1}{1.2} + 2\left(\frac{0.001}{0.006}\right)$$

$\Delta E = 0.6 \times 10^{14}$ J [A1]

$E = (1.1 \pm 0.6) \times 10^{14}$ J [A1]

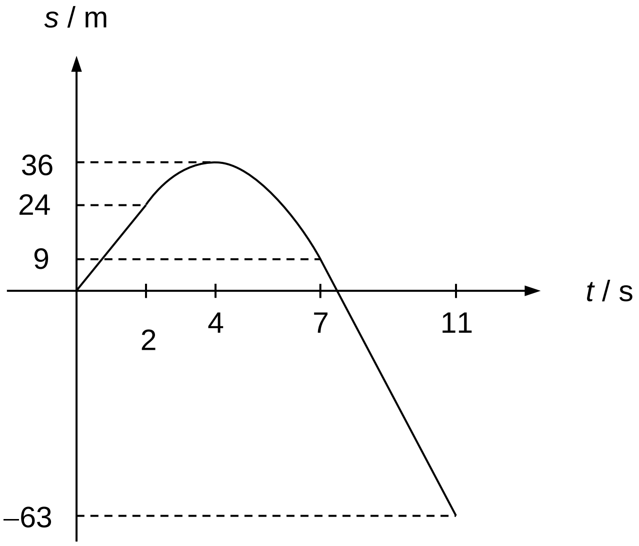
2 **(a)** Velocity is defined as the rate of change of displacement with respect to time.

(b) **(i)** $s = (12 \times 2) + \left(\frac{1}{2} \times 12 \times 2\right) - \left(\frac{1}{2} \times 18 \times 3\right) - (18 \times 4)$

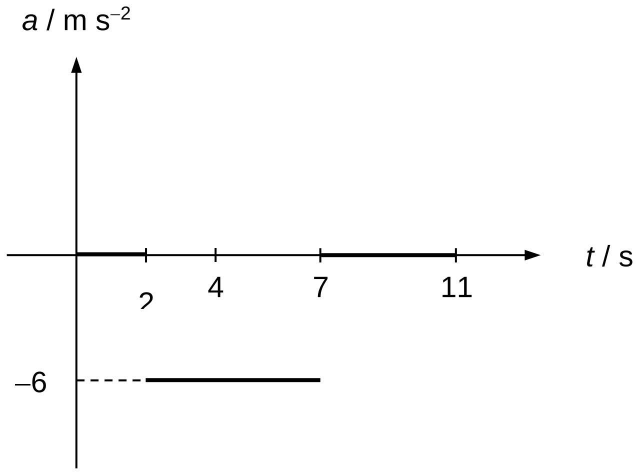
$= -63 \text{ m}$

(ii) Curve from 2 to 7 s, highest point at 4 s, smooth line at 2 and 7 s.

Straight line with positive gradient from 0 to 2 s, straight line with negative gradient from 7 to 11 s.
Correct displacements at 2, 4, 7, 11 s.



(iii) Horizontal lines for 0 to 2 s, 7 to 11 s, $a = 0$ m s^{-2}.
Horizontal line from 2 to 7 s, $a = -6$ m s^{-2}.



3 **(a)** If body A exerts a force <u>on body B</u>, then body B exerts a force of the <u>same type</u> that is <u>equal in magnitude</u> and <u>opposite in direction</u> <u>on body A</u>. [1]

(b) Force by rocket on water = $\dfrac{\Delta p_{water}}{\Delta t} = \left(\dfrac{m_{water}}{\Delta t}\right)\Delta v$

= mass of water ejected per unit time × v [1]

By Newton's 3rd Law, the thrust (force) T, of rocket due to ejected water is equal to the force by rocket on ejected water. [1]

Taking upwards as positive, net force on the rocket F is

$F = T - W$ where W is the weight of rocket [1]

$= \pi r^2 \rho v \times v - mg$

Hence $F = \pi r^2 \rho v^2 - mg$

(c) (i) Initial thrust will be the same as the gas pressure remains the same. [1]

Alternative Solution

Initial thrust will be greater as the total pressure at the nozzle is greater due to a larger volume (height) of water above it.

Further elaboration

Pressure at nozzle = Initial air pressure + water pressure
= Initial air pressure + $\rho g(V/A)$

Where g is gravitational field strength, V is volume of water and A is cross sectional area of bottle, assuming cylindrical bottle.

BUT the additional water pressure is about 1000 $\times$ 10 $\times$ 0.1 = 1000 Pa (not very significant compared to 160000 Pa) assuming A of about 20 cm^3

(ii) Magnitude of initial acceleration will be smaller as mass of rocket and its contents is greater. [1]

$$Acceleration = \frac{\pi r^2 \rho v^2}{m} - g = \frac{\pi r^2 \rho v^2}{\rho V} - g$$
$$= \frac{\pi r^2 v^2}{V} - g$$

Since velocity of ejected water v remains the same (increase is insignificant), the initial acceleration experienced is smaller.

(iii) Maximum height reached is smaller because the acceleration experienced by the toy is smaller. [1]

4	(a)	**(i)** Consider if the block (with penny) start to slide first, $F_1 = 0.40\,(m_1 + m_2)g = (m_1 + m_2)r\omega^2$ (m_1 & m_2 are mass of block and penny respectively) $\omega = \left(0.40 \times \frac{9.81}{0.12}\right)^{0.5} = 5.72 \text{ rad s}^{-1}$	M1 A1
		(ii) Consider if the penny starts to slide first, $F_2 = 0.52\,(m_2)g = (m_2)r\omega^2$ $\omega = \left(0.52 \times \frac{9.81}{0.12}\right)^{0.5} = 6.52 \text{ rad s}^{-1}$	M1 A1
		(iii) Max allowable $\omega = 5.72 \text{ rad s}^{-1}$	M1
		Number of revolution per minute = $\frac{\omega}{2\pi} \times 60 = 54.6$ min^{-1}	A1
	(b)	Friction provides the centripetal force for mud to stay in circular motion. $F_{friction} = mrw^2 = centripetal\ force.$ The required centripetal force increases as *r* increases	M1

			so flies off at edge first if the required centripetal force is greater than frictional force.	A1
5	(a)		The gravitational potential at a point is defined as the work done per unit mass by an external agent in bringing a small test mass from infinity to that point, without producing any acceleration of the test mass.	B1
	(b)	(i)	$\emptyset_p = 4\emptyset_{due\ to\ 1\ mass\ at\ P}$	M1
			$= -4\frac{Gm}{\sqrt{R^2+h^2}}$	A1
		(ii)	Loss in $E_{k\ (from\ P\ to\ infinity)}$ = Gain in $E_{P\ (from\ P\ to\ infinity)}$ $\frac{1}{2}Mv^2 - 0 = M\left[0 - \left(-4\frac{Gm}{\sqrt{R^2+h^2}}\right)\right]$	M1
			$v = \frac{\sqrt{8Gm}}{\sqrt[4]{R^2+h^2}}$	A1
6	(a)		A straight line passing through the origin ⇒ acceleration is directly proportional to displacement. Negative gradient ⇒ direction of acceleration is opposite to the direction of displacement The features of the graph show that $a \propto -x$ (defining equation for SHM)	B1 B1 B1
	(b)	(i)	Energy stored in spring = ½ kA^2 = ½ (100)(0.200)^2 = 2.00 J	A1
		(ii)	Loss in EPE = Gain in KE 2.00 = ½ $(m_1 + m_2)v^2$ 2.00 = ½ $(9.00 + 7.00)v^2$	M1
			v = 0.500 m s^{-1}	A1
			OR	
			$\omega = (k/m)^{1/2}$ = (100/(9.00+7.00))$^{1/2}$ = 2.50 rad s^{-1}	M1
			$v = r_0\omega$ = (0.200)(2.50) = 0.500 m s^{-1}	A1
		(iii)	Loss in KE = Gain in EPE $\frac{1}{2}m_1v^2 = \frac{1}{2}kA'^2$ $\frac{1}{2}(9.00)(0.500)^2 = \frac{1}{2}(100)(A')^2$	M1
			A' = 0.150 m	A1
			OR	
			$\omega = \sqrt{\frac{k}{m}}$ $= \sqrt{\frac{100}{9.00}}$ = 3.33 rads^{-1}	M1
			$v = A'\omega$ 0.500 = A'(3.33) A' = 0.150 m s^{-1}	A1

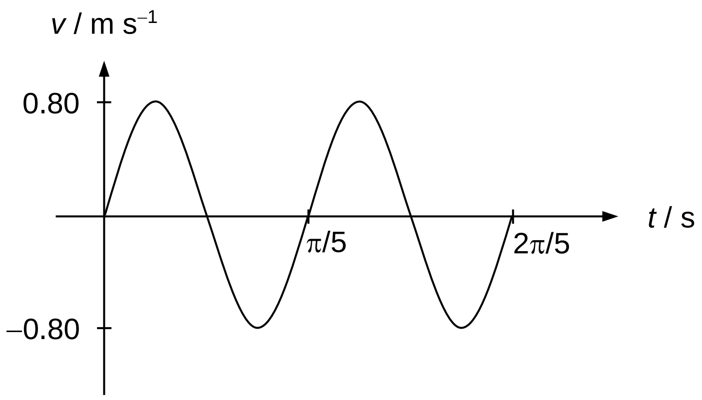
7 **(a)** $v_0 = \omega x_0 = \left(\frac{2\pi}{T}\right) x_0$ [M1]

$= \left(\frac{2\pi}{\pi/5}\right)(0.080)$

$= 0.80 \text{ m s}^{-1}$ [A1]

(b) sine graph [B1]

y-axis labeled correctly [B1]



(c) $v = \omega\sqrt{x_0^2 - x^2}$

$x = \sqrt{x_0^2 - \frac{v^2}{\omega^2}}$ [M1]

$= \sqrt{(0.080)^2 - \frac{(0.42)^2}{10^2}}$

$= 0.068\ m = 6.8 \text{ cm}$

Displacement = –6.8 cm [A1]

(d) At equilibrium point, $mg = ke$

$e = \frac{mg}{k}$

$= \frac{0.200 \times 10}{20}$

$= 0.10 = 10 \text{ cm}$ [M1]

At highest point,

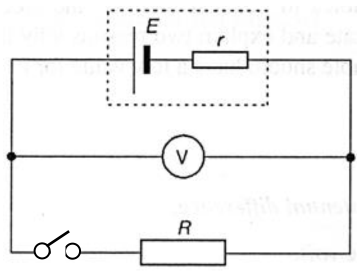
$\text{EPE} = \frac{1}{2}ke^2$

$= \frac{1}{2}(20)(0.10 - 0.080)^2$

$= 0.0040 = 4.0 \text{ mJ}$ [A1]

(e)

	Lowest Point	Equilibrium Point	Highest Point
Gravitational Potential Energy / mJ	0	160	320
Elastic Potential Energy / mJ	324	100	4
Kinetic Energy / mJ	0	64	0

8	**(a)**	**(i)**	Total charge of particles = (e)(n)(A)(L)	B1
		(ii)	Time taken for all particles to pass through shaded area = L / v	B1
		(iii)	Current = charge flow per unit time = [(e)(n)(A)(L)] / (L / v) = $n\,A\,v\,e$	M1 B1 A0
	(b)		Faulty: C Nature: lamp is shorted **OR** Lamp has no resistance.	B1 B1
	(c)		R = 15 Ω	A1
	(d)		$V = IR$ $R = \frac{6.0}{0.20} = 30\ \Omega$	A1
	(e)		Filament is cold when measuring with ohm-meter	B1
			and the resistance of the filament lamp rises as temperature increases	B1
			OR	
			The increased temperature led to increased resistance Temperature of 2 cases highlighted to have increased OR Lattice vibrations increased with temperature increase.	B1 B1
	(f)	**(i)**	 S **1.** S is open to measure E; **2.** S is closed to measure V.	B1 B1 B1
		(ii)	**1.** $R = \frac{V^2}{P} = \frac{11.6^2}{20.0}$ $= 6.73\ \Omega$ **2.** Rearranging the equation $V = E - Ir$, we obtain $1 = \frac{E}{V} - \frac{r}{R}$ $r = R\left(\frac{E}{V} - 1\right) = 6.73\left(\frac{15.0}{11.6} - 1\right) = 1.97\ \Omega$	M1 A1 M1 C1 A1

End