PLKTYTC
2018 – 2019
Mock Examination Papers 1B
Solutions

1. (a) (i) Energy transferred during the first 15 minutes

$= mc\Delta T = (8)(4200)(100 - 25)$

$= 2.52 \times 10^6$ J **(1A)**

(ii) Energy transferred during the next 5 minutes

$= (2.52 \times 10^6) \times (5/15)$

$= 8.40 \times 10^5$ J **(1M)**

Mass of water boiled away

$= (8.40 \times 10^5) / (2.26 \times 10^6)$

$= 0.372$ kg **(1A)**

(b) (i) The pot is made of clay. **(1A)**

To keep the soup boiling for more than one minute, the pot should be a good insulator of heat so as to reduce heat loss. **(1A)**

(ii) Just after the pot is removed from the stove, the temperature of the pot is still higher than 100 °C, so it continues to transfer heat to the soup for a short time. **(1A)**

2. (a) By $p_1/T_1 = p_2/T_2$, the expected gas pressure

$p_2 = p_1T_2/T_1 = (1.0 \times 10^5)(80 + 273) / (25 + 273)$ **(1M)**

$= 1.18 \times 10^5$ Pa **(1A)**

(b) <u>Groupmate A was wrong</u>. The thermometer directly <u>measures the water</u> **(1A)** <u>temperature</u>. So the heat loss from the water does not affect the result. **(1A)**

<u>Groupmate B was also wrong</u>.The volume inside the rubber tubing is fixed **(1A)** throughout the experiment. <u>This satisfies the fixed-volume condition</u>, so this extra volume does not affect the result. **(1A)**

(c) (i) When the temperature increases, the gas molecules move faster. **(1A)**

They hit the wall more frequently and vigorously. **(1A)**

Therefore, the gas pressure increases.

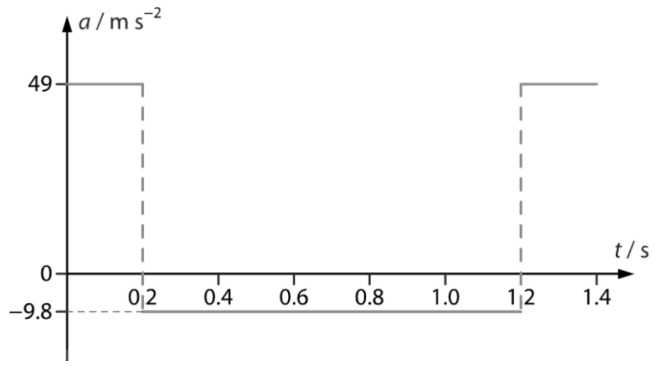
(ii) The graph obtained would remain the same. **(1A)**

3. (a) Height difference = area under the curve between t = 0.1–0.7 s **(1M)**

= (0.7 − 0.1)(4.9)/2 = 1.47 m **(1A)**

(b) (i) Between t = 0–0.2 s, a = (4.9 − (−4.9))/(0.2 − 0) = 49 m s^{-2} **(1M)**

Between t = 0.2–1.2 s, a = (−4.9 − 4.9)/(1.2 − 0.2) = −9.8 m s^{-2}



(1A)

(ii) Between t = 0–0.2 s (and between t = 1.2–1.4 s) **(1A)**

(iii) Net force on Carl, $F = ma$ = (60)(49) = 2940 N **(1M)**

Or: $F = \Delta mv/\Delta t$ = ((60)(4.9) – (60)(–4.9))/0.2 = 2940 N

Force by trampoline = 2940 + (60)(9.81) **(1M)**

= 3530 N **(1A)**

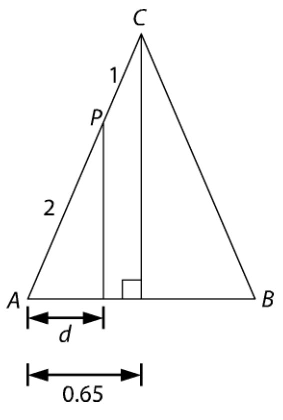
(c) No, the total energy of Carl was not conserved. **(1A)**

It is because Carl and the trampoline exerted forces and did work on each other.

(1A)

4. (a) The net force and the net moment about any point are both zero. **(1A)**

(b) (i) Consider the following triangles. The lengths are in metres.



By considering the two similar right-angled triangles,

$$\frac{d}{0.65} = \frac{2}{3} \quad \Rightarrow \quad d = 0.4333 \text{ m}$$ **(1A)**

Therefore, the horizontal distance of the painter from A is 0.433 m.

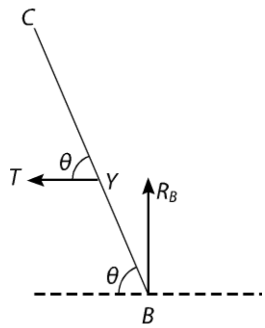
(b) (ii) From (a), we know that the sum of the normal reaction at *A* and that at *B* is equal to the weight of the painter, i.e. $R_A + R_B = mg = (70)(9.81) = 686.7$ N. **(1M)**

Take moment about *A*. The anticlockwise moment should be balanced by the clockwise moment, i.e.

$$\begin{aligned} mgd &= R_B(1.3) \\ (686.7)(0.4333) &= R_B(1.3) \\ R_B &= 228.9\,\text{N} \end{aligned}$$ **(1M+1A)**

So, the normal reaction at *B* is 229 N, and
the normal reaction at *A* is 686.7 − 228.9 = 457.8 ≈ 458 N. **(1A)**

(c) Consider the right half of the ladder *BC* and the forces acting on it.



The angle between *BC* and the horizontal is

$$\begin{aligned} \cos\theta &= \frac{0.65}{3} = 0.2167 \\ \theta &= 77.49^\circ \end{aligned}$$ **(1A)**

Take moment about *C*. Since *BC* is at rest, the anticlockwise moment should be balanced by the clockwise moment, i.e.

$$\begin{aligned} (T\sin\theta)(1.7) &= (R_B\cos\theta)(3) \\ (T\sin 77.49^\circ)(1.7) &= (228.9 \times 0.2167)(3) \\ T &= 89.66\text{ N} \end{aligned}$$ **(1A)**

The tension in *XY* is 89.7 N.

(d) When he bends his knees, his centre of gravity is further lowered (gives him less chance to topple). **(1A)**

This lengthens the time of impact, and thus reduces the collision force on him. **(1A)**

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(a)	Gravitational field strength $g = \dfrac{GM_E}{r^2}$	1M
	$= \dfrac{6.67\times10^{-11}\times5.97\times10^{24}}{(6736\times10^3)^2}$	
	$= 8.78\text{ N kg}^{-1}$	1A
(b)	Net force acting on the astronaut = mg	
	$= 70 \times 8.78$	
	$= 615$ N	1A
(c)	$\dfrac{GM_E m}{r^2} = mr\omega^2$	1M
	$\omega = \sqrt{\dfrac{8.78}{6736\times10^3}}$	
	$= 0.001\ 141\text{ rad s}^{-1}$	
	$T = \dfrac{2\pi}{\omega} = \dfrac{2\pi}{0.001141}$	1A
	$= 5505$ s	
	$= 91.7$ min	1A
	The period of the space station is 91.7 minutes.	
(d)	No change	1A
	By $mr\omega^2 = mg$,	
	$\omega = \sqrt{\dfrac{g}{r}}$	
	Angular speed (and hence period) is independent of the mass of the space station.	1M

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(a)	Fringe separation $\Delta y = \dfrac{4.3\text{cm}}{10}$	1A
	$= 0.43$ cm	
	$= 4.3 \times 10^{-3}$ m	
	By $\Delta y = \dfrac{\lambda D}{a}$,	
	wavelength $= \dfrac{a\Delta y}{D}$	
	$= \dfrac{(0.1\times10^{-3})(4.3\times10^{-3})}{0.8}$	1M
	$= 5.38 \times 10^{-7}$ m	1A
(b)	Increase	1A
(c)	The slit width is much larger than the wavelength of the light,	1A
	so no significant diffraction occurs.	1A
	A single light spot can be observed on the screen.	1A

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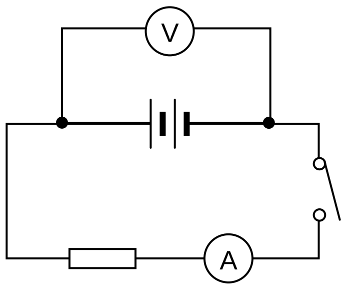

(Correct circuit)	1A
(Correct symbols)	1A
Record the reading of the voltmeter ε when the switch is open.	1A
Close the switch. Record the reading of the voltmeter V and the reading of the ammeter I.	1A
Internal resistance r of the battery can be found by:	
$\varepsilon = V + Ir$	1A
$r = \dfrac{\varepsilon - V}{I}$	

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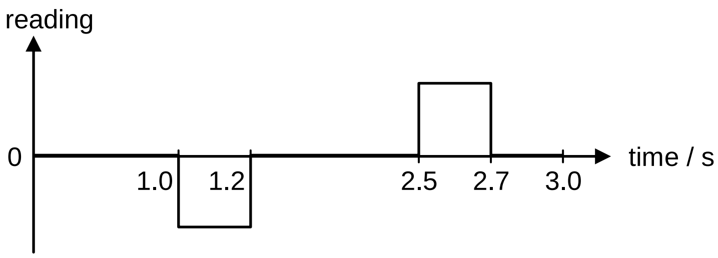
(a) **(i)**



(2 constant induced emfs)	1A
(Correct signs of readings)	1A
(All other parts correct)	1A

(ii)

Induced e.m.f. $= N\dfrac{\Delta\Phi}{\Delta t}$	
$= 50 \times \dfrac{(5\times10^{-4})(0.02\times0.02)}{1.2-1.0}$	1M
$= 5 \times 10^{-5}$ V	1A
Alternative method:	
Induced e.m.f. $= Bvl$	1M
$= (5 \times 10^{-4})(0.1)(0.02 \times 50)$	
$= 5 \times 10^{-5}$ V	1A

(b) Any two of the following: — 2 × 1A

Move the coil faster.
Using a pair of stronger magnets.
Using a coil with more turns.
Increase the length of the coil cutting the magnetic field.

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(a)	Upwards	1A
(b)	Electric field strength $= \dfrac{F}{q}$	1M
	$= \dfrac{(9.11\times10^{-31})(1.8\times10^{16})}{1.60\times10^{-19}}$	1A
	$= 1.02 \times 10^5$ N C^{-1}	1A
(c)	Time $t = \dfrac{s_x}{v_x} = \dfrac{0.5\times10^{-2}}{3\times10^7}$	1A
	$= 1.667 \times 10^{-10}$ s	
	$\approx 1.67 \times 10^{-10}$ s	1A
(d)	$v_y = u_y + a_y t$	1M
	$= 0 + (1.8 \times 10^{16})(1.667 \times 10^{-10})$	
	$= 3.00 \times 10^6$ m s^{-1}	1A
	$\tan\theta = \dfrac{v_y}{v_x} = \dfrac{3.00\times10^6}{3\times10^7} = 0.1$	1M
	$\theta = 5.71°$	1A
(e)	Increase	1A

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(a)		${}^{14}_{7}\text{N} + {}^{1}_{0}\text{n} \rightarrow {}^{14}_{6}\text{C} + {}^{1}_{1}\text{p}$	1A
		(Accept using *X* in the equation.)	
		X is a proton / hydrogen nucleus.	1A
(b)	**(i)**	Nitrogen-14	1A
	(ii)	Similarity (any one):	1A
		Both come from the nucleus of an atom.	
		Both are ionizing.	
		Both carry high energy.	
		Both have high penetrating power.	
		Difference (any one):	1A
		β radiation is a stream of electrons while γ radiation is EM wave.	
		β radiation carry negative charge while γ radiation is neutral.	
		β radiation can be deflected by electric/magnetic field while γ radiation cannot.	
		β radiation has a higher ionizing power than γ radiation.	
		β radiation has a lower penetrating power than γ radiation.	
		β radiation travels slower than γ radiation.	
(c)	**(i)**	$0.065 = 0.26 \times \left(\dfrac{1}{2}\right)^2$	1M
		$\therefore$ 2 half-lives have passed.	
		Age of wood = 2 × 5730 = 11 460 years ≈ 11 500 years	1A
	(ii)	The concentration of carbon-14 in the atmosphere in ancient time was lower.	1A
		A shorter time should have been elapsed, i.e. the actual age of the wood should be smaller than the estimation.	1A
	(iii)	No.	1A
		The radiation from a sample is very weak.	1A