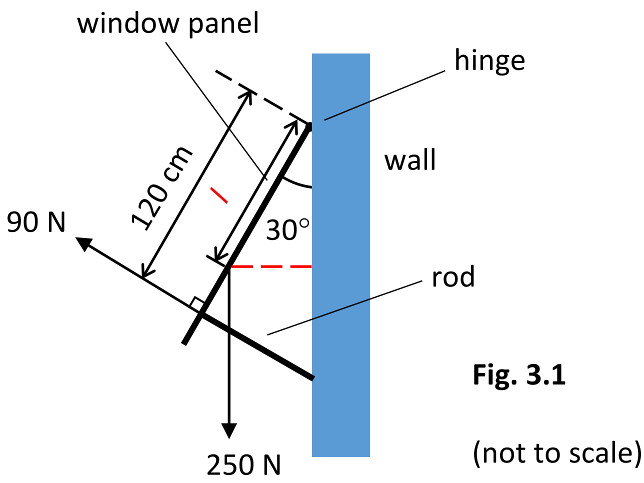
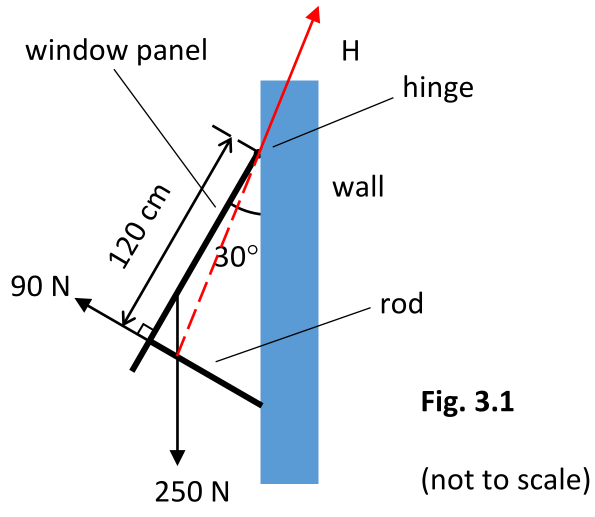
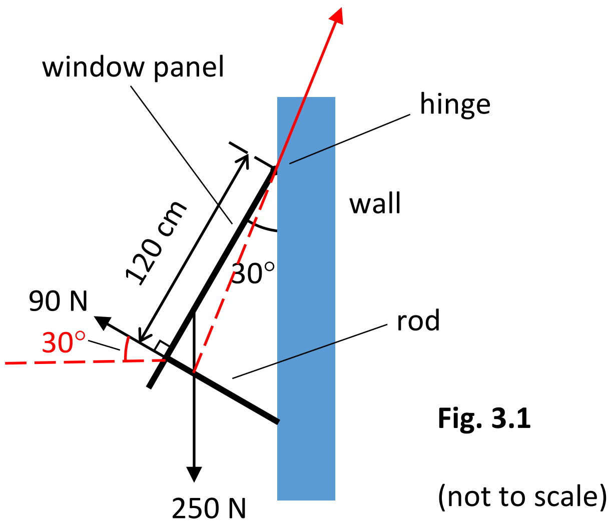
EUNOIA JUNIOR COLLEGE
JC2 MIDYEAR EXAMINATIONS 2024
8867 H1 PHYSICS
MARK SCHEME

Qns	Answer	Marks
1(a)	density $\rho = \frac{M}{V} = \frac{M}{\frac{1}{3}\pi r^2 h} = \frac{0.170}{\frac{1}{3}(3.14)(2.50\times10^{-2})^2(0.12)} = 2164 \text{ kg m}^{-3}$ $\frac{\Delta\rho}{\rho} = \frac{\Delta M}{M} + 2\left(\frac{\Delta r}{r}\right) + \frac{\Delta h}{h} = \frac{0.001}{0.170} + 2\left(\frac{0.01}{2.50}\right) + \frac{0.1}{12.0} = 0.0222$ $\Delta\rho = 0.0222(2160) = 48 \approx 50 \text{ kg m}^{-3}$ (1 s.f.) $\therefore (2160 \pm 50) \text{ kg m}^{-3}$ **Examiner's Comments** Candidates are advised to be familiar with the Mathematical requirement of the H1 Physics syllabus. For example, if the shape in question was a rectangular, cylinder or sphere, the formula for volume would not be given. If remembering "give value to the same d.p. as uncertainty" gives problem, candidates might benefit from remembering "give value to the same place value as the significant number". In this case, the uncertainty was 5 tens. Hence density was given to the nearest tens.	**C1** density **C1** Fractional uncertainty formula **C1** uncertainty **A1**
1(b)	No. The two masses are individually pulled down the slope with have the **same acceleration** down the slope. Whether the masses are allowed to slide alone or with the other mass, they would still experience the same acceleration. **Examiner's Comments** The key word in the question was "are allowed to slide down". This suggests that there is no applied force on the masses, and the only force causing the motion down the slope is the component of their weight down the slope, and their acceleration down the slope is $g \sin\theta$.	**B1**
1(c)(i)	Consider both masses (as a system), $F = ma$ $350 = (10+11)a$ $a = 16.7 \text{ m s}^{-1}$ **Examiner's Comments** Taking both masses as 1 system, the acceleration of the system can be found. And each of the mass would have the same acceleration as the system.	**C1** **A1**
1(c)(ii)	Consider mass A (as a system), $F = ma$ $N = (10)(16.7)$ $N = 167 \text{ N}$ **Examiner's Comments** In this question, it was deliberate that the force asked for is the contact force by mass B on mass A. If the force that was asked for the contact force my mass A on mass B, Newton's 3rd Law would need to be invoked.	**C1** **A1**

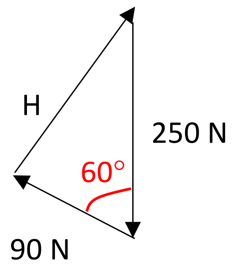
Qns	Answer	Marks
2(a)	Rate of change of velocity. **Examiner's Comments** Well done!	**B1**
2(b)(i)	Area under graph $= \frac{1}{2}(0.6)(6+12)$ $= 5.4$ m **Examiner's Comments** The key to this question is to identify the point at which the ball hit the floor, which is at *t* = 0.6 s, when there is a sudden change in velocity due to the bounce on the floor.	**C1** **A1**
2(b)(ii)	The ball experienced an **inelastic collision** with the floor and **lost energy**. With **less kinetic energy** at the point it leaves the floor, it has a **smaller rebound speed**. **Examiner's Comments** Quite a few key phrases were expected for this question for the answer to be clear. Candidates are advised to review the answers to this question carefully.	**B1** **B1**
2(b)(iii)	The **gradients of the lines represent acceleration** of the ball, which is a **constant at 9.81 m s^{-2}** in the absence of air resistance. **Examiner's Comments** Since question explicitly mentioned gradient, candidates are expected to state the concept of the gradient representing acceleration of the ball.	**B1** **B1**

Qns	Answer	Marks
3(a)	1. The net / resultant / sum of force(s) acting on the window panel is zero. 2. The net / resultant / sum of moment about any point acting on the window panel is zero. **Examiner's Comments** Candidates should ensure that they quote according to lecture notes to avoid missing out keywords. Candidates should NOT quote the principle of moments.	B1
3(b)	The centre of gravity of the window panel is the point where its weight appears to act. **Examiner's Comments** A few candidates wrongly used the word "mass" instead of weight. Centre of mass and centre of gravity carries different meaning.	B1
3(c)	Fig. 3.1 (not to scale) Let the distance be l. sum of clockwise moments = sum of anticlockwise moments $90 \times 120 = 250 \times l \times \sin 30°$ $l = 86.4$ cm **Examiner's Comments** Candidates need to learn to resolve forces correctly.	C1 A1

3(d)	 **Fig. 3.1** (not to scale) Line of action goes through the intersection of weight and force due to rod. Arrow points up and right. **Examiner's Comments** Candidates do not appear to be aware that 3 non-collinear forces acting on a body must pass through a single point in space.	**B1**
3(e)	 **Fig. 3.1** (not to scale) Method 1: Resolving forces $F_{hori} = 90 \times \cos 30° = 77.9$ N, $F_{vert} = 250 - 90 \times \sin 30° = 205$ N magnitude $= \sqrt{77.9^2 + 205^2} = 219.3 = 219$ N Method 2: Vector diagram.	

$H^2 = 90^2 + 250^2 - 2 \times 90 \times 250 \times \cos 60^o$

H = 219 N



Qns	Answer	Marks
4(a)	*Newton's Second Law of Motion* states that the rate of change of momentum of a body is **[magnitude]** directly proportional to the resultant force acting on it and **[direction]** takes place in the direction of the resultant force. **Examiner's Comments** Candidates are advised to put effort into memorising definitions word for word to avoid missing out key ideas.	**B1**
4(b)(i)	change in momentum of A = impulse on A = area under F-t graph $\Delta p = \frac{1}{2}(1.0 \times 10^{-3})(4.0 \times 10^{3})$ $= 2.0$ N s **Examiner's Comments** For those who were able to relate to area under the graph, a notable number missed out one of the powers of tens.	**C1** Area under graph **A1**
4(b)(ii)	Since the force is acting on cart A (by B) acts leftwards, change in momentum is leftwards. **Examiner's Comments** Candidates should be aware that the direction of change of momentum provides the direction of the force. **For Learning:** This is basically the application of Newton's 2^{nd} Law (in terms of direction). Refer to answer for 4(a).	**B1**
4(b)(iii)	Take the right direction as positive, $\Delta p_A = m(v_A - u_A)$ $-2.0 = (1.5)[v_A - (+3.0)]$ $v_A = +1.7 \text{ m s}^{-1}$ Velocity of A after collision is to the right. **Examiner's Comments** The most common error is the failure to correctly consider the sign of Δp. **For Learning:** Just like $F_{net} = ma$ where the signs of both F_{net} and a are the same, in this case, the signs of both Δp and Δv (hence v and u) need to be considered. Both equations are related to Newton's Second Law!	**C1** **A1** (both dirn & mag required)

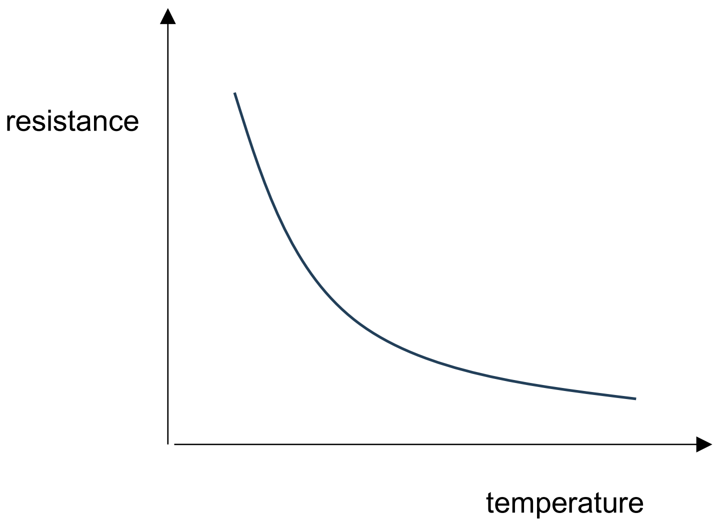
4(c)	Relative speed of approach before collision = rate of decrease of distance between carts = 3.0 m s^{-1} Relative speed of separation after collision = rate of increase of distance between carts = (2.4 – 1.7) = 0.70 m s^{-1}	**B1**
	Since the relative speed of approach is not equal to the relative speed of separation, the collision is not elastic. **Examiner's Comments** Poor presentation was a common problem that presented in this question. When trying to prove that 2 quantities are NOT equal, students should tackle the LHS and RHS of the equations separately and conclude accordingly after that. A handful of students also memorized the relationship incorrectly. It should be "$u_1 - u_2 = v_2 - v_1$" (1-2-2-1).	**B1**

Qns	Answer	Marks
5(a)	Power is the rate of work done. **Examiner's Comments** Generally well done. Candidates should note that they should not say "rate of work done per unit time" as this would suggest dividing by time twice, since rate already presents the idea of "per unit time".	**A1**
5b(i)	loss in KE $= \frac{1}{2}mv^2 = \frac{1}{2}\left(8.0\times10^6\right)\left(0.60\right)^2$ $= 1440000$ J $= 1.44\times10^6$ J **Examiner's Comments** Full credit was denied if the answer is a negative (or implies so) since KE is indeed lost in this case. **For Learning:** Loss = Initial – Final Gain = Final – Initial Change = Final – Initial	**C1** **A1**
5(b)(ii)	1. $F = ma$ $120000 = \left(8.0\times10^6\right)a$ $a = 0.015$ m s^{-1} 2. $a = \frac{v-u}{t}$ $0.015 = \frac{0-0.60}{t}$ $t = 40$ s	 **M1** **A1** **C1** **A1**
5(b)(ii)	$P_{ave} = \frac{\text{decrease in } E}{t} = \frac{\frac{1}{2}mv^2}{t} = \frac{\frac{1}{2}\left(8.0\times10^6\right)\left(0.60\right)^2}{40}$ $= 36000$ W **Examiner's Comments** **For Learning:** Power = *Fv* is not applicable here as the question asks for average power, not instantaneous power. These are not the same in this case, given that the *v* is constantly changing due to *F*. It would give the same answer if <v> is used instead (0.30 m s^{-1}).	**M1** **A1**

Qns	Answer	Marks
5(b)(iii)	Some possibilities: 1. Viscous force slows the ferry down and makes stopping distance shorter. 2. Wind blows in the direction that ferry was travelling and makes the stopping distance longer.	**M1**

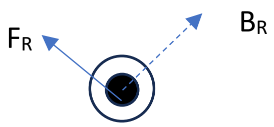
Qns	Answer	Marks
6(a)	Angular velocity is the **rate of change of angular displacement** swept out by radius.	A1
6bi	ω = (20 x 2π) / 60 = 2.09 rad s^{-1} **Examiner's Comments** Common error included considering T = 20/60 s instead of T = 60/20 s.	A1
6bii	$a = r\,\omega^2$ $9.81 = r\,(2.094)^2$ $r = 2.24$ m **Examiner's Comments** Generally well done.	M1 A1
6biii	[observe] The exercise bike has a shorter turning radius than the cage. [explain] Since acceleration is proportional to the radius of circular motion, astronaut on bike would not experience as much acceleration and hence artificial gravity. **Examiner's Comments** To answer this part correctly, candidates were expected to observe from the diagram that the radius of the biker is shorter.	B1
6(c)	Gravitational force provides centripetal force. $F_G = F_c$ $\frac{GMm}{r^2} = r\omega^2 = r\left(\frac{2\pi}{T}\right)^2$ $\frac{(6.67 \times 10^{-11})M}{(3.84 \times 10^8)^2} = (3.84 \times 10^8)\left(\frac{2\pi}{27.324 \times 60 \times 60}\right)^2$ $M = 6.02 \times 10^{24}$ kg **Examiner's Comments** Candidates are reminded of the importance of writing the Physics statement before proceeding to the equation itself (for B1 mark). Many candidates also committed the grave mathematical error of cancelling "*r*" instead of multiplying it to obtain "r^3".	B1 C1 A1

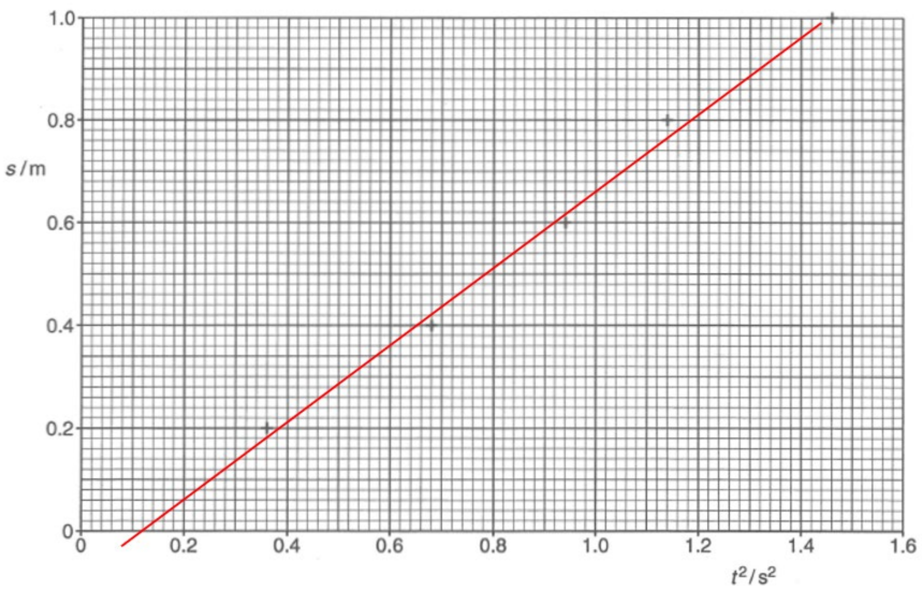
Qns	Answer	Marks
7a	Electromotive force is the energy transformed from chemical energy to electrical energy **per unit charge** when charge is driven round a complete circuit. **Examiner's Comments** Candidates are advised to learn the definition in full and to avoid paraphrasing unnecessarily. The words in bold were essential to be awarded full credit.	A1
7bi	$\frac{1}{R_{//}} = \frac{1}{10} + \frac{1}{20} \Rightarrow R = 6.67\ \Omega$ $R = 5.0 + 6.67$ $R = 11.7\ \Omega$ **Examiner's Comments** Mostly well done. Candidates who were denied full credit most likely identified the 3 resistors being connected in parallel – please indicate the flow of current at each part of the circuit to identify their connection!	C1 A1
7bii	$V = RI$ $24 = (11.7)I$ $I = 2.1\text{ A}$ **Examiner's Comments** Mostly well done! Keep it up!	C1 A1
7biii	$P = I^2R = (2.1)^2(5)$ $= 21\text{ W}$ **Examiner's Comments** Strangely, a few candidates used the e.m.f of the cell in the calculation of the power dissipated in the 5Ω resistor. Candidates are reminded to be careful in their choice of values.	C1 A1

Qns	Answer	Marks
7ci	 **Examiner's Comments** Mostly well done! Keep it up!	A1
7cii	As temperature of thermistor increase, its resistance decreases. Hence, **TOTAL** resistance in the circuit decreases, and **TOTAL** current in the circuit increases. Since resistance of the resistor remains constant, the potential difference across it would increase. OR **By potential divider rule**, potential difference across resistor increases. **Examiner's Comments** Answers by most candidates were incomplete. If the relationship between resistance and potential difference is made, then invoking potential divider rule is important. Else, candidates were expected to provide full explanation.	B1 B1

Qns	Answer	Marks
8(a)	Magnetic flux density is the force acting per unit current per unit length on a wire carrying a current that is normal to the magnetic field. **Examiner's Comments** Common missing words are "acting", "on a wire", and "carrying a current". Wrong phrases such as force per unit charge are also common.	**B1** **B1**
8(b)	Within: parallel lines, right to left Outside: 1 straight, 2 incomplete, 2 loops, correct direction (left to right) **Examiner's Comments** Recommended: 5 lines in total, one straight line, 2 incomplete, 2 loops, no crossing at any point Mostly wrong direction or lack of lines.	**B1**
8(c)(i)	Since the stiff wire CD carry a carry a **current** and is placed **perpendicular** in **an uniform B-field**, it will **experience a magnetic force**. By **Fleming's Left Hand Rule**, the **magnetic force will be acting upwards or downwards** (depending of direction of current), which will **produce a moment about the pivot.** **Examiner's Comments** Descriptions were often vague or wrong.	**B1** **B1**
8(c)(ii)	The **current flowing through the wire CB and DE** is **parallel** to the magnetic field **in the solenoid**, hence **no magnetic force** is experienced. **Examiner's Comments** Some of the candidates were able to answer this questions correctly.	**B1**
8(c)(iii) 1.	Direction = out of paper or C to D **Examiner's Comments** Candidates who understood the problem were able to give the right answer.	**B1**
8(c)(iii) 2.	Using principle of moment, taking pivot about BE, anticlockwise moment = clockwise moment $BIL(d_1) = Fd_2$ $B(4.9)(25\times10^{-3})(106\times10^{-3}) = (5.7\times10^{-4})(77\times10^{-3})$ $B = 3.38\times10^{-3}$ T **Examiner's Comments** Mostly well done.	**B1** **C1** **A1**

8(d)	*Nuclear fusion* is a nuclear reaction where two light nuclei combine to form a nucleus of greater mass. **Examiner's Comments** Candidates were able to recall the definition if they studied.	**B1**
8(d)(i)	Energy released $= \Delta m\, c^2$ $= [(2.0141 + 3.0161 - 4.0026 - 1.0087)(1.66 \times 10^{-27})]\,(3.00 \times 10^{8})^2$ $= 2.82 \times 10^{-12}$ J **Examiner's Comments** Well done.	**B1** **C1** **A0**
8(d)(iii)	No. of ${}^{2}_{1}H$ nuclides = $\dfrac{70.0}{2.0141(1.66 \times 10^{-27})} = 2.09 \times 10^{28}$ No. of ${}^{3}_{1}H$ nuclides = $\dfrac{80.0}{3.0161(1.66 \times 10^{-27})} = 1.60 \times 10^{28}$ Since 1 of each nuclide take part in 1 reaction, the maximum number of possible reactions is 1.60×10^{28}. **Examiner's Comments** Well done.	**M1** **A1**
8(d)(iv)	Total energy harvested $= (1.60 \times 10^{28})(2.82 \times 10^{-12})(0.08)$ $= 3.61 \times 10^{15}$ J Duration $= \dfrac{3.61 \times 10^{15}}{1.50 \times 10^{9}}$ $= 2.41 \times 10^{6}$ s $= 27.9$ days **Examiner's Comments** Well done by most who were able to tackle the efficiency portion and power conversion.	**C1** **C1** **A1**
8dv	At high temperatures, the hydrogen nuclides have high average kinetic energies. They hence have sufficient energy to overcome the forces of electrostatic repulsion between them (since both are positively-charged) and come close enough to undergo fusion. **Examiner's Comments** Very few good answers were encountered.	**B1** **B1**

Qns	Answer	Marks
9(a)	Magnetic flux density is the force acting per unit current per unit length on a wire carrying a current that is normal to the magnetic field. **Examiner's Comments** Common missing words are "acting", "on a wire", and "carrying a current". Wrong phrases such as force per unit charge are also common.	**B1**
(b)(i)	$F = BIL$ $\frac{F}{L} = BI$ $= (6.5x10^{-5})(6.5)$ $= 4.225x10^{-4}$ $= 4.23x10^{-4}\text{N m}^{-1}$ **Examiner's Comments** Well done by most candidates. Force per unit length carries different meaning from force acting on 1 meter of wire. The ratio of Force to the length of the wire will give the unit of Nm^{-1}. If you use 1 meter to substitute into F= BIL, the unit of Force is N.	**M1** **A1**
(ii)1.	(Perpendicular) Out of the plane of the paper **Examiner's Comments** Some candidates could not apply the right hand grip rule.	**B1**
(ii)2.	 By Fleming's Left Hand Rule, the force is perpendicular to the current and BR. **Examiner's Comments** Many candidates could not apply the Flemming's Left Hand Rule properly.	**B1** **B1**
(c)(i)1.	$F = Bqv\sin 55^{o}$ $= (0.24)(1.6x10^{-19})(1.5x10^{5})\sin 55^{o}$ $= 4.72x10^{-15}\text{N}$ **Examiner's Comments** Candidates has difficulty resolving the vector to get the correct component vector.	**M1** **A1**
(c)(i)2.	The force on the particle is (always) perpendicular to the velocity/ perpendicular to the direction of travel /towards the centre of path No work is done by the force on the particle.	**B1**

	Examiner's Comments Many candidates still have fundamental concept errors in circular motion.	**B1**
(c)(i)3.	The component of velocity parallel to the magnetic field makes the electron move in the direction of the B field in at constant speed. The component of velocity perpendicular to the magnetic field makes the electron move in a circular path. Hence, the electron moves in a helical path. **Examiner's Comments** Only a few candidates can explain the motion correctly.	**B1** **B1**
9(d)(i)	Line of best fit.  	**B1**
1(d)(ii)	Gradient $= \dfrac{0.96 - 0.06}{1.38 - 0.20}$ $= 0.762$	**B1** Read coordinates correct to ½ division **A1**
1(d)(iii)	$s = ut + \dfrac{1}{2}at^2$ When s is plotted against t^2, gradient $= \dfrac{1}{2}a$ $0.762 = \dfrac{1}{2}a$ $a = 1.52$ m s^{-2}	**C1** **A1**

	Examiner's Comments Candidates were able to draw the best fit and calculate the gradient correctly. Candidates were unable to relate the graph to the kinematics equation to find the acceleration.	
9(e)(i)	Data points are scattered about the line of best fit. **Examiner's Comments** Poor explanations were given.	**B1**
9(e)(ii)	Line of best fit does not pass through the origin. **Examiner's Comments** Well done.	**B1**
9(f)	Best fit line provides the trend of the data points and compensates / balance out random errors which can be both over-estimates and under-estimates of the true value. **Examiner's Comments** Poorly answered. Candidates are advised to learn how to explain using solutions provided.	**B1**