PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



MARK SCHEME

SECTION 1: FORCES AND MOTION (PACK 1)

SCORE	PERCENTAGE
/204	%

STEMUP

These questions belong to Pearson Edexcel, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by Pearson Edexcel. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with Pearson Edexcel and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. Pearson Edexcel has not endorsed, approved or been involved in the production of it. Pearson Edexcel and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

Pearson Edexcel publishes its past papers, mark schemes and examiner reports. Always check the current specification at qualifications.pearson.com before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a)	A helium **nucleus** / 2 protons and 2 neutrons/ 4 nucleons, 2 protons;	Ignore chemical symbol	1
(b) (i)	Arrow labelled Y, through X away from nucleus; Line of action of force would pass through centre of nucleus by eye;		2
(ii)	Arrow labelled Z, opposite direction to their answer from b) (i) by eye; Same size as their answer from b) (i) by eye;	If no arrow Y, condone correct direction for arrow Z, i.e. force arrow pointing away from point X.	2
(iii)	MP1 Force on alpha is repulsive; MP2 Alpha and nucleus must be same (type of) charge; MP3 Alpha is positive **therefore** nucleus is positive;	Allow 'like charges repel' for MP1 and MP2	3
(c)	Selection of F = ma; Substitution or re-arrangement; Evaluation; e.g. a = 3.6 / 6.6 x 10^{-27} = 5.5 x 10^{26} m/s^2	Can be implied from working -1 for PoT error Allow 5.45 x 10^{26}, 5.454 x 10^{26}, 5.4545... x 10^{26} etc Condone 5.4 x 10^{26}	3

Q2.

Question number	Answer	Additional guidance	Mark
(a)(i)	Acceleration = change in velocity ÷ time taken	allow in words or acceptable symbols	**1**

Question number	Answer	Additional guidance	Mark
(a)(ii)	Process includes: • substitution • evaluation • unit e.g. acceleration = 46/0.20 (1) acceleration = 230 (1) unit = m/s^2 (1)	mark independently	3

Question number	Answer	Additional guidance	Mark
(b)(i)	Momentum = mass × velocity	allow in words or acceptable symbols e.g. $p = m \times v$	1

Question number	Answer	Additional guidance	Mark
(b)(ii)	Process includes: • conversion of mass to kg • substitution • evaluation e.g. 0.057 kg seen anywhere (1) (p =) 0.057 × 46 (1) (p =) 2.6 (kg m/s)(1)	2622 gains 2 marks allow 2.622	3

Question number	Answer	Mark
(c)	An explanation that makes reference to three of the following points: • increase impact time (1) • (for) same change of momentum (1) • reference to force = change of momentum/time (1) • reduces force (1)	3

(Total for question = 11 marks)

Q3.

Question number		Answer	Notes	Marks
(a)	(i)	centre of gravity / centre of mass;	allow centre of weight	1
	(ii)	balance / newtonmeter;	allow newton scales ignore scales	1
(b)	(i)	moment = force × (perpendicular) distance;	allow standard symbols and rearrangements e.g. moment = F × d ignore m for moment	1
	(ii)	substitution; e.g. 0.68 × 4.3 (= 2.924 N cm)		1
	(iii)	idea that anti-clockwise moment = clockwise moment; rearrangement; evaluation; e.g. 2.9 = F × 11 F = 2.9 / 11 (F =) 0.26 (N)	stated or implied by working allow ECF from (ii) allow 0.2636...-0.2658... allow 0.27 condone 0.263	3
			(Total for Question = 6 marks)	

Q4.

Question number	Answer	Notes	Marks
(a) (i)	X drawn at the base of the weight arrow;	judge by eye	1
(ii)	weight = mass × gravitational field strength;	allow standard symbols and rearrangements e.g. $W = m \times g$ ignore 'gravity' for g	1
(iii)	substitution; evaluation; e.g. (W =) 130 × 10 (W =) 1300 (N)	 -1 for POT error only e.g. from incorrectly converting kg to g allow g = 9.8, 9.81 allow 1274, 1275.3	2
(b) (i)	in equilibrium / when balanced; (sum of) clockwise moment(s) = (sum of) anti-clockwise moment(s);	 allow idea that net moment is zero	2
(ii)	correct expression for either moment; correct use of principle of moments; evaluation of distance X; e.g. 1300 × 0.30 OR 520 × X 1300 × 0.30 = 520 × X X = 0.75 (m)	allow ecf from (a)(iii)	3
(iii)	(length of plank =) 1.5 (m);	allow ecf from (b)(ii)	1

Q5.

Question number	Answer	Notes	Marks
(a)	substitution into $v^2 = u^2 + 2as$; rearrangement; evaluation; e.g. $75^2 = (0^2 +) 2 \times 4.1 \times s$ $s = 5625 / 8.2$ (s =) 690 (m)	allow alternative method of finding the time taken and then using **average** speed = distance/time 1371-1372 = 2 marks allow 686, 685.9756...	3
(b) (i)	any two from: MP1. idea of radiation that is always present / present everywhere; MP2. idea of no 'obvious' source; MP3. any valid source of background radiation given e.g. radon/rocks/cosmic rays/medical or military activity/the Sun etc.;		2
(ii)	any three from: MP1. idea that excessive exposure time can be harmful/increases risk; MP2. idea that dosage is higher (at maximum height); MP3. idea that increased risk of cancer; MP4. idea that there is less atmosphere to absorb cosmic radiation; MP5. cosmic rays/radiation is increased;	allow cell mutation for cancer	3
		(Total for Question = 8 marks)	

Q6.

Question number	Answer	Notes	Marks
(a)	(force to the) right; (because) opposite charges attract / like charges repel;	allow 'towards the positive plate" or "away from the negative plate"	2
(b)	line drawn showing the ink drop deflecting to the right of the centre and hitting paper below; line drawn starts vertical and becomes increasingly more curved as the ink drop moves towards paper;	allow ECF from (a) if direction of force to the left DOP	2
(c) (i)	substitution into force = mass × acceleration; rearrangement; evaluation; e.g. $8.5 \times 10^{-7} = 1.1 \times 10^{-10} \times a$ (a =) $8.5 \times 10^{-7} / 1.1 \times 10^{-10}$ (a =) 7700 (m/s^2)	 -1 for POT error allow 7727.27...	3
(ii)	use of $v^2 = u^2 + (2 \times a \times s)$; substitution OR rearrangement; evaluation in metres; conversion to mm; e.g. $v^2 = u^2 + (2 \times a \times s)$ $3.9^2 = 0 + (2 \times 7700 \times s)$ OR $s = (v^2 - u^2) / 2a$ (s =) 9.9×10^{-4} (m) (s =) 0.99 (mm)	can be implied from substitution allow ECF from (i) independent mark award if correct conversion attempted on incorrect answer allow 9.8×10^{-4} - 9.9×10^{-4} allow 0.98 - 0.99	4

(d)	idea of swapping polarities of plates; idea of increasing the amount of charge on plates;	allow positively charging ink drop allow increasing amount of charge on ink drop allow decreasing {mass or volume} of the ink drop	2

Q7.

Question number	Answer	Notes	Marks
(a) (i)	idea that the dome loses electrons;	however expressed reject if idea that positive charge has been transferred	1
(ii)	substitution into $E = V \times I \times t$; rearrangement; evaluation; e.g. $0.50 = 120\,000 \times I \times 15$ $I = 0.50 / [120\,000 \times 15]$ $(I =) 2.8 \times 10^{-7}$ (A)	ignore units -1 for POT error allow 0.000 000 277...(A) condone 2.7×10^{-7} (A)	3
(b) (i)	any three from: MP1. metal case loses electrons; MP2. (because) metal case is a conductor; MP3. dome and metal case have the same charge; MP4. repulsion between dome and metal case;	 allow metal case becomes (positively) charged	3
(ii)	any four from: MP1. repulsive force from dome decreases as separation increases; MP2. named downward force e.g. weight, air resistance acts on the case; MP3. (eventually, resultant) downwards force acts on case; MP4. causing the case to slow down; MP5. kinetic energy decreases; MP6. gravitational potential energy increases; MP7. kinetic energy becomes zero (at maximum height);	 allow speed becomes zero	4

Q8.

Question number	Answer	Notes	Marks
(a)	A; B cannot be correct as it measures distance C cannot be correct as it measures temperature D cannot be correct as it measures voltage		1
(b) (i)	momentum = mass × velocity;	accept standard symbols e.g. p for momentum reject m or M for momentum	1
(ii)	72 × 13 = 936;		1
(iii)	substitution into given equation; correct evaluation; correct answer: 3200 (N) e.g. force = change in momentum ÷ time taken = 936 ÷ 0.29 = 3200 (N)	accept use of Δp of 900, 936 or 940 expect values of 3103, 3228 and 3241	2
(iv)	A cannot be correct as increasing the force does not protect the driver C cannot be correct as they would both increase the force on the person D cannot be correct as the airbag decreases the momentum		1

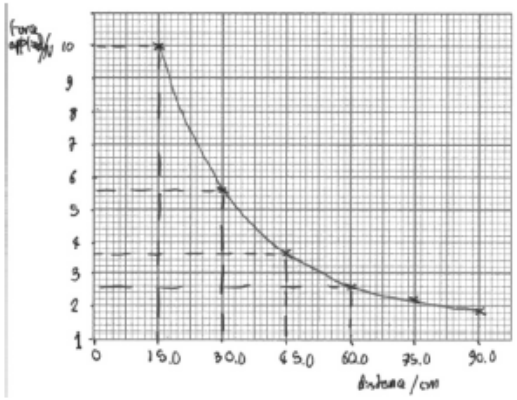
Q9.

Question number	Answer	Notes	Marks
(a)	centre of gravity;	allow centre of mass	1
(b) (i)	C (230 N); A is not correct as this is the mass of the bin; B is not correct as this has the incorrect unit for force; D is not correct as the mass has been converted to grams before being multiplied by *g*.		1
(ii)	(in equilibrium) sum of clockwise moments = sum of anticlockwise moments;	condone 'clockwise moment = anticlockwise moment'	1
(iii)	calculation of moment of weight or expression for moment of F; equating moments; rearrangement for F; correct evaluation of F; e.g. moment of F = 0.98 x F moment of weight = 230 x 0.37 230 x 0.37 = 0.98 x F F = 230 x 0.37 / 0.98 F = 87 (N)	ignore POT for this MP allow 86.8, 86.84, 86.83...	4
(iv)	Magnitude=candidate's answer for (iii); direction: down(wards);	expect 87 N	2
		Total for Question	= 9 marks

Q10.

Question number	Answer	Notes	Marks
(a)	Centre of gravity;	Accept 'Centre of Mass'	1
(b) (i)	Moment = force x (perpendicular) distance;	Condone M = f x d	1
(ii)	Any correct moment; i.e. 2.1 x 0.28 or W x 0.032 Evidence of use of principle of moments; i.e. 2.1 x 28 = W x 3.2 Re-arrangement ; i.e. W = 2.1 x 28 /3.2 Evaluation; W = 18 (N)	Allow calculation performed in cm Accept unrounded 18.375, 18.4 N. Condone for 1 mark statement of principle of moments.	4

Q11.

Question number	Answer	Notes	Marks
(a)	(metre) rule(r)/(metal) tape measure;	allow (Vernier) caliper(s)	1
(b) (i)	3.6;	allow 3.7	1
(ii)	idea that the reading would be larger than the range of the instrument;		1
(c) (i)	suitable linear scale chosen (>50% of grid used); axes labelled with quantities and units; plotting correct to nearest half square;  	ignore plotting of 45cm point	3
(ii)	line (curve) of best fit acceptable;	allow ECF from plotting i.e. smooth curve with points evenly distributed about it	1

(d)	any four from: MP1. as distance increases, **force** decreases; MP2. (because) moment = force x distance; MP3. any one calculated moment value from results table or graph; MP4. a second calculated moment value from results table or graph; MP5. evidence shows moments are not all the same; MP6. (but) no pattern in the data (so could be attributed to experimental errors);	no mark for simply 'student is right/wrong' allow evidence shows moments are similar allow consistent conclusion i.e. variation isn't large enough	4

Q12.

Question number	Answer	Notes	Marks
(a) (i)	Selection of P=F/A; Conversion of g to kg; Evaluation of weight; Evaluation of pressure; Correct answer: 140 (Pa) i.e. $W = 3.7 \times 10^{-3} \times 10 = 3.7 \times 10^{-2}$ N; $P = 3.7 \times 10^{-2} / (2.6 \times 10^{-4})$; P = 140 (Pa);	 0.0037 seen anywhere Accept any value that rounds to 140. i.e 142, 142.3, Accept use of 9.8(1) for 'g', giving 139(.46)	4
(ii)	Same weight (and larger cross-sectional area); P=F/A so smaller pressure;	Allow 'force' for weight	2
(b)	Increases continuously from -10 °C to 0 °C; Remains constant at 0 °C; Increases continuously from 0 °C to 20 °C;	Responses with no period of time at 0 °C score max 1 mark. Accept • Any gradient • Straight lines or curves for the increasing temperature parts • Any non-zero amount of time at 0 °C by eye Ignore any numbers on the time axis.	3
(c)	Any TWO from: Bonds between particles are weakened or broken; Particles go from regular to irregularly packed/EQ; Particles go from vibrating (about a fixed position) to sliding past each other/EQ;	 Allow particles get (slightly) further apart/EQ; ignore references to KE	2

Q13.

Question number	Answer	Notes	Marks
(a)	300 (metres);		1
(b)	0.554; any answer given to 2 sf; correct answer = 0.55 (s) e.g. (0.50+0.62+0.52+0.58+0.55)/5 = 0.554 (s) = 0.55 (s) to 2 s.f.	mark independently	2
(c)	difference in distance is 180 m; recall of equation: speed = distance / time taken; substitution; correct evaluation; correct answer = 330 (m/s) e.g. speed = (300 - 120)/0.55 speed = 180/0.55 speed = 327.2727... (m/s)	allow use of standard symbols e.g. v = d/t condone s for v, s for d ECF incorrect distance and ECF incorrect time from (b) answer is 327.2727... (m/s) answer is 324.90... (m/s) if 0.554(s) is used	4
(d)	human reaction time;	accept alternative valid variables e.g. wind speed, temperature, humidity, air pressure	1
		Total for Question : 8 marks	

Q14.

Question number	Answer	Notes	Marks
(a)	correct substitution KE = ½ (mass) × (speed)²; re-arrangement to give v; evaluation to show 5.8(4...) (m/s); e.g. KE = ½ m v² 0.29 = 0.5 × 0.017 × v² v² = 0.29 ÷ (0.5 × 0.017) = 34.1176471.. v = √34.1176471 = 5.8(4...) (m/s)	allow use of standard symbols e.g. KE = ½ m v² allow mass = 17 at this point	3
(b)	idea of conservation of momentum; idea that momentum before release was zero; evidence of re-arrangement; evaluation of large block speed giving 1.3 m/s; e.g. momentum of small block = 17 × 6 = 102 g m/s therefore momentum of large block = 102 g m/s momentum = mass × velocity = 75 v so v = 102/75 = 1.36 m/s	however expressed allow idea that momenta of two blocks is equal in magnitude allow 1.4 if v_{small} = 6 m/s ignore mass unit provided both masses consistent v=1.31 if v_{small} = 5.8 m/s v=1.32 if v_{small} = 5.84 m/s	4
(c)	substitution into given equation; idea of initial momentum = 0; evaluation; correct answer = 0.93 (N) e.g. force = change in momentum ÷ time taken force = ((0.017 × 6) - 0) ÷ 0.11 force = 0.102 ÷ 0.11 force = 0.9272... (N)	 allow use of init velocity = 0	3
(d)	substitution and re-arrangement of given equation; conversion of 17.6 cm to 0.176 m; evaluation; correct answer = 0.18(41...) (s) e.g. orbital speed=(2π × orbital radius)÷time period 6 = (2π × 0.176)÷T T = (2π × 0.176) ÷ 6 T = 0.1843... (s)	 accept 0.2 (s) accept use of v=5.84...(m/s) -1 POT error 0.092.. (s) for using 17.6 cm as a diameter scores 2 marks	3
		Total for Question : 13 marks	

Q15.

Question number	Answer	Notes	Marks
(a)	(to the) left; (because) repulsion (due to like magnetic poles);	allow towards A, away from B ignore backwards reject if mention of charge	2
(b) (i)	0.045 (kg m/s);	allow 'the same'	1
(ii)	momentum of B after collision = 0.045 – (-0.021); evaluation; e.g. 0.045 - −0.021 (momentum =) 0.066 (kg m/s)	 allow 0.024 for 1 mark allow 0.045 + 0.021	2
(iii)	substitution into F = change in momentum / time taken; evaluation; e.g. F = 0.066 / 0.19 (F =) 0.35 (N)	allow ECF from (ii) use of 0.024 from (ii) gives 0.126... (N) allow 0.347... (N)	2
(iv)	(to the) right;	allow towards B, away from A	1
		(Total for Question = 8 marks)	

Q16.

Question number	Answer	Notes	Marks
(a) (i)	substitution into F = (mv - mu)/t; evaluation; correct direction; e.g. (F =) (6.7 - −4.2) / 0.012 (F =) 910 (N) (direction =) right	 -1 if POT error independent mark 208.3... scores 2 marks max. if given with correct direction allow 908.3...(N) allow forwards ignore compass directions 0.9083... scores 1 mark	3
(ii)	same forces as in (a)(i) AND <u>opposite</u> direction; e.g. (F =) 910 (N) AND (direction =) left	allow ECF from (a)(i) for both points allow ECF for compass direction only if opposite to direction given in (i)	1
(b)	any three from: MP1. idea that there is a change of momentum (when ball hits player); MP2. (equipment) increases (impact) time; MP3. decreases rate of change of momentum (of ball); MP4. decreases force (on player); MP5. decreases pressure (on player);	 allow spreads force over larger area	3

Q17.

Question number	Answer	Notes	Marks
(a) (i)	position of the mass hanger;	allow distance of mass hanger/eq reject unqualified "distance"	1
(ii)	any two from: MP1. weight or mass of metre rule MP2. weight or mass of mass hanger; MP3. positions of newton meter(s);	ignore "same equipment"	2
(iii)	any one from: • take repeats and find mean; • extend the range of the results; • measure more intermediate positions; • repeat to {identify/remove} anomalies; • plot a graph to spot anomalies;		1
(b) (i)	all data plotted to within half a small square;		1
(ii)	straight line passing through all points;	allow straight line with points evenly distributed either side if plotting error in (i)	1
(iii)	any four from: MP1. as position of mass hanger increases, reading on newton meter A decreases; MP2. as position of mass hanger increases, reading on newton meter B increases; MP3. relationship(s) are linear; MP4. idea that newton meter readings are the same when the position is 50cm; MP5. idea that the sum of the newton meter readings is constant;	accept "as A decreases, B increases" for MP1 & MP2 ignore references to proportionality	4
(c)	any three from: MP1. idea that clockwise moment equals anti-clockwise moment; MP2. distance of mass hanger from newton meter B decreases; MP3. (therefore) anti-clockwise moment of mass hanger weight (about B) decreases; MP4. clockwise moment (of newton meter A reading) decreases (thereby decreasing reading);	allow idea that moments must balance allow distance from newton meter A increases	3
		Total for Question	= 13 marks

Q18.

Question number	Answer	Notes	Marks
(a)	D (kg m/s); A is incorrect because this would be from mass / velocity B is incorrect because this would be from mass^2 × velocity C is incorrect because this would be from mass × velocity^2		1
(b) (i)	idea that (total) momentum before (collision) = (total) momentum after (collision) (in the absence of external forces);	allow references to explosion/event, rather than collision 'momentum is conserved' is insufficient	1
(ii)	setting up equation using conservation of momentum; rearrangement; evaluation; e.g. 0 = [1.9 × 3.7] + [2.9 × v] v = -7.03 / 2.9 (v =) -2.4 (m/s)	using either substitution of correct values or algebraically allow [1.9 × 3.7] = [2.9 × v] allow 2.42... (m/s) ignore sign of final answer correct evaluation of object Q's momentum i.e. (-)7.03 (kg m/s) scores 1 mark if no other mark scored	3

(c)	idea of carpet increases impact time; carpet reduces rate of change of momentum (for the same speed or momentum of egg); (carpet) reduces force;	ignore references to hard/soft floors ignore references to absorbing force or reduction in 'impact' ignore references to energy allow RA allow RA allow reference to given equation or word equation allow reduces deceleration or acceleration allow RA	3
			Total for Question = 8 marks

Q19.

Question number	Answer	Notes	Marks
(a)	substitution into momentum = mass × velocity; evaluation; e.g. p = 0.0041 × 0.15 (p =) 0.00062 (kgm/s)	allow use of standard symbols e.g. p = m × v -1 for POT error allow decimal or standard form allow 0.000615	2
(b)	velocity of ball increases; momentum increases;	allow ball speeds up	2
(c)	substitution into F = (mv - mu) / t; rearrangement; evaluation; e.g. 1.3 = 0.0041 × v (- 0) / 0.0025 (v =) 1.3 × 0.0025 / 0.0041 (v =) 0.79 (m/s)	 -1 for POT error allow 0.79268...	3

Q20.

Question number	Answer	Notes	Marks
(a) (i)	momentum = mass × velocity;	allow standard symbols and rearrangements e.g. p = m × v reject use of m for momentum	1
(ii)	substitution; evaluation to 2 or 3 s.f.; e.g. (p =) 17 × 2.9 (p =) 49 (kg m/s)	 allow 49.3 (kg m/s)	2

(b)	(i)	use of conservation of momentum; momentum of stone A after collision calculated; momentum of stone B after collision calculated; evaluation of velocity of stone B; e.g. momentum before = momentum after $p_A = (17 \times 0.4 =) 6.8$ $p_B = (50 - 6.8 =) 43.2$ $(v_B = 43.2 / 19 =) 2.3$ (m/s)	seen written explicitly or implied by working allow, for 1 mark only, "(total) momentum before = (total) momentum after" if no other marks scored. allow 42.5, 42.2 from non-rounded values for (a) allow 2.27... (m/s) allow 2.22..., 2.23...	4
	(ii)	conversion of ms to s; substitution into $F = \Delta p / t$; evaluation of force; e.g. t = 0.025 s F = 43.2 / 0.025 (F =) 1700 (N)	allow ÷1000 / 0.025 seen anywhere in working no mark for formula alone as given in paper 2 marks max. for POT error e.g. 1.7 (N) allow ecf from (b)(i) allow answers in the range 1688-1728 accept, in full, responses including use of 'F = ma' provided correct values for u, v and Δt to calculate a.	3

Q21.

Question number	Answer	Notes	Marks
(a)	use/substitution of distance = average speed x time; total distance travelled = 2 x distance to plane; evaluation of distance to at least 2s.f.; e.g. total distance = $1.9 \times 10^{-3} \times 3.0 \times 10^{5}$ total distance = 570 km = 2 x distance to plane distance to plane = 570/2 = 285 (km)	reject use of $v=f\lambda$ allow idea that time required is half of total time.	3
(b)	substitution into given equation $\Delta\lambda/\lambda = v/c$; rearrangement; evaluation; e.g. $1.1 \times 10^{-6} / 1.2 = v/3 \times 10^{8}$ $v = 3 \times 10^{8} \times 1.1 \times 10^{-6} / 1.2$ v = 280 (m/s)	 -1 POT error allow ecf from wrong change in wavelength condone premature rounding allow 275 (m/s)	3
		Total for Question	= 6 marks

Q22.

Question number	Answer	Notes	Marks
(a)	idea that extension increases as force increases; idea of a linear relationship;	ignore positive correlation allow "force is proportional to extension" for 2 marks if no other marks scored then mention of Hooke's law scores 1 mark	2
(b)	substitution into moment = force × distance; evaluation of moment to at least 3s.f.; e.g. moment = 480 × (0.)84 moment = 403 (Nm)	ignore units 1 mark max. for reverse calculation e.g. calculating the force or the distance allow 403.2 (Nm)	2
(c)	idea of principle of moments; moment of push force = F × 3.2; rearrangement; evaluation; e.g. 403.2 = F × 3.2 F = 403.2 / 3.2 (F =) 130 (N)	implied by substitution or written in words seen anywhere in calculation -1 for POT error allow use of 400 Nm, giving 125 N allow use of 403 Nm, giving 125.9..., 126 (N) clockwise moment = anti-clockwise moment allow 126 (N)	4
(d)	idea of spring exceeding/reaching elastic limit; idea of permanent deformation / not returning to original shape / permanent stretching;	ignore idea of spring losing elasticity / stop stretching allow limit of proportionality for elastic limit ignore spring breaking	2
		Total for Question = 10 marks	