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PHYSICS



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Paper 1 Multiple Choice Answers: Dynamics

Question	Paper	Q. No.	Answer
251	9702_m20_qp_12	6	D
252	9702_m20_qp_12	8	D
253	9702_s20_qp_11	8	A
254	9702_s20_qp_11	11	D
255	9702_s20_qp_12	7	B
256	9702_s20_qp_13	8	D
257	9702_s19_qp_11	9	B
258	9702_s19_qp_12	9	C
259	9702_s19_qp_12	10	A
260	9702_s19_qp_12	14	D
261	9702_s19_qp_13	10	B
262	9702_w19_qp_11	6	C
263	9702_w19_qp_11	7	A
264	9702_w19_qp_11	8	C
265	9702_w19_qp_12	7	D
266	9702_w19_qp_13	8	D
267	9702_m18_qp_12	7	B
268	9702_m18_qp_12	10	C
269	9702_s18_qp_11	8	A
270	9702_s18_qp_12	8	D
271	9702_s18_qp_13	7	C
272	9702_w18_qp_11	7	A
273	9702_w18_qp_11	8	C
274	9702_w18_qp_12	7	B
275	9702_w18_qp_13	7	B
276	9702_w18_qp_13	8	A
277	9702_w18_qp_13	10	C
278	9702_m17_qp_12	9	D
279	9702_s17_qp_11	7	B
280	9702_s17_qp_11	10	A
281	9702_s17_qp_12	7	C
282	9702_s17_qp_12	8	B
283	9702_s17_qp_12	9	C
284	9702_s17_qp_13	7	D
285	9702_s17_qp_13	9	D
286	9702_s17_qp_13	10	A
287	9702_s17_qp_13	16	C
288	9702_w17_qp_11	9	B
289	9702_w17_qp_11	10	D
290	9702_w17_qp_12	10	B
291	9702_w17_qp_13	8	D
292	9702_w17_qp_13	9	B
293	9702_w17_qp_13	13	C
294	9702_m16_qp_12	9	B
295	9702_s16_qp_12	9	C
296	9702_w16_qp_11	9	A

Paper 1 Multiple Choice Answers: Dynamics (continued)

Question	Paper	Q. No.	Answer
297	9702_w16_qp_11	11	A
298	9702_w16_qp_12	12	D
299	9702_w16_qp_12	13	B
300	9702_w16_qp_13	9	A
301	9702_w16_qp_13	11	A
302	9702_s15_qp_11	14	C
303	9702_s15_qp_12	10	C
304	9702_s15_qp_12	13	A
305	9702_s20_qp_11	9	C
306	9702_s20_qp_12	8	C
307	9702_s20_qp_13	9	B
308	9702_m19_qp_12	7	C
309	9702_m19_qp_12	9	A
310	9702_s19_qp_11	10	C
311	9702_w19_qp_12	8	D
312	9702_s18_qp_12	7	C
313	9702_s18_qp_13	8	B
314	9702_w18_qp_12	8	B
315	9702_m17_qp_12	8	A
316	9702_s17_qp_11	8	C
317	9702_s17_qp_13	8	C
318	9702_s16_qp_12	10	C
319	9702_s16_qp_13	12	C
320	9702_w16_qp_11	10	C
321	9702_w16_qp_11	12	D
322	9702_w16_qp_13	10	C
323	9702_w16_qp_13	12	D
324	9702_s15_qp_11	10	D
325	9702_s15_qp_11	12	C
326	9702_s15_qp_11	13	A
327	9702_m20_qp_12	10	B
328	9702_s20_qp_11	10	D
329	9702_s20_qp_12	9	D
330	9702_s20_qp_13	10	C
331	9702_m19_qp_12	8	B
332	9702_s19_qp_11	11	D
333	9702_s19_qp_12	11	D
334	9702_s19_qp_13	9	C
335	9702_w19_qp_11	10	C
336	9702_w19_qp_12	9	A
337	9702_w19_qp_13	9	B
338	9702_s18_qp_11	9	B
339	9702_s18_qp_12	9	C
340	9702_s18_qp_13	9	C
341	9702_w18_qp_11	9	D
342	9702_w18_qp_12	9	B

Paper 1 Multiple Choice Answers: Dynamics (continued)

Question	Paper	Q. No.	Answer
343	9702_w18_qp_12	10	D
344	9702_m17_qp_12	10	B
345	9702_s17_qp_12	14	C
346	9702_w17_qp_11	11	D
347	9702_w17_qp_12	9	C
348	9702_w17_qp_13	10	A
349	9702_m16_qp_12	10	B
350	9702_m16_qp_12	11	C
351	9702_s16_qp_11	9	A
352	9702_s16_qp_11	10	D
353	9702_s16_qp_12	11	D
354	9702_s16_qp_13	10	A
355	9702_w16_qp_11	13	A
356	9702_w16_qp_12	11	A
357	9702_w16_qp_13	13	A
358	9702_s15_qp_11	11	C
359	9702_s15_qp_12	11	D
360	9702_s15_qp_13	10	C
361	9702_s15_qp_13	11	C
362	9702_s15_qp_13	12	B
363	9702_s15_qp_13	13	C

32. 9702_s15_qp_23 Q: 1

(a)	150 or 1.5×10^2 Gm	A1	[1]
(b)	distance = $2 \times (42.3 - 6.38) \times 10^6$ (= 7.184×10^7 m)	C1	
	(time =) $7.184 \times 10^7 / (3.0 \times 10^8) = 0.24$ (0.239) s	A1	[2]
(c)	units of pressure P: kg m s^{-2} / m^2 = kg m^{-1} s^{-2}	M1	
	units of density ρ: kg m^{-3} and speed v: m s^{-1}	M1	
	simplification for units of C: $C = v^2 \rho / P$ units: (m^2 s^{-2} kg m^{-3}) / kg m^{-1} s^{-2} and cancelling to give no units for C	A1	[3]
(d)	energy and power *(both underlined and no others)*	A1	[1]
(e) **(i)**	vector triangle of correct orientation	M1	
	three arrows for the velocities in the correct directions	A1	[2]
(ii)	length measured from scale diagram 5.2 ± 0.2 cm or components of boat speed determined parallel and perpendicular to river flow	C1	
	velocity = 2.6 m s^{-1} (allow ± 0.1 m s^{-1})	A1	[2]

33. 9702_w20_qp_21 Q: 3

	Answer	Mark
(a)	(force =) rate of change of momentum	**B1**
(b)(i)	$E = \frac{1}{2}mv^2$ **or** $\frac{1}{2} \times 0.062 \times 3.8^2$ **or** $\frac{1}{2} \times 0.062 \times 1.7^2$	**C1**
	loss of KE = $\frac{1}{2} \times 0.062 \times (3.8^2 - 1.7^2)$ = 0.36 J	**A1**
(b)(ii)	$p = mv$ **or** 0.062×3.8 **or** 0.062×1.7	**C1**
	change in momentum = $0.062 \times (1.7 + 3.8)$ = 0.34 N s	**A1**
(b)(iii)	(average resultant force =) 0.34 / 0.081 = 4.2 (N) **or** (average resultant force =) $0.062 \times (1.7 + 3.8) / 0.081 = 4.2$ (N)	**A1**
(b)(iv)	**1.** average force = 4.2 + (0.062×9.81) = 4.8 N	**A1**
	2. average force = 4.8 N	**A1**

34. 9702_s19_qp_21 Q: 2

	Answer	Mark
(a)	(momentum =) mass × velocity	B1
(b)(i)	time = 40 ms	A1
(b)(ii)	**1.** (the magnitude of the acceleration is) constant	B1
	2. (the magnitude of the acceleration is) zero	B1
(c)	$F = \Delta p / (\Delta)t$ **or** F = gradient	C1
	e.g. $F = 0.50 / 40 \times 10^{-3}$ $= 13$ N	A1
(d)	horizontal line from (0, 0.40) to (60, 0.40)	B1
	straight line from (60, 0.40) to (100, –0.10)	B1
	horizontal line from (100, –0.10) to (160, –0.10)	B1

35. 9702_w17_qp_21 Q: 1

	Answer	Mark
(a)	units of F: kg m s^{-2}	C1
	units of ρ: kg m^{-3} **and** units of v: m s^{-1}	C1
	units of K: $\text{kg m s}^{-2} / [\text{kg m}^{-3} (\text{m s}^{-1})^2]$ $= \text{m}^2$	A1
(b)(i)	$K\rho = 1.5 / 33^2$	C1
	$= 1.38 \times 10^{-3}$ $F_D = 1.38 \times 10^{-3} \times 25^2$ **or** $F_D / 1.5 = 25^2 / 33^2$ $F_D = 0.86$ N	A1
(b)(ii)	$a = (1.5 - 0.86) / (1.5 / 9.81)$ **or** $a = 9.81 - [0.86 / (1.5 / 9.81)]$	C1
	$a = 4.2 \text{ m s}^{-2}$	A1
(c)	initial acceleration is g/9.81 (m s^{-2})/acceleration of free fall	B1
	acceleration decreases	B1
	final acceleration is zero	B1

36. 9702_s20_qp_22 Q: 2

	Answer	Mark
(a)(i)	area = $ut + \frac{1}{2}(v - u)t$ **or** area = $vt - \frac{1}{2}(v - u)t$ **or** area = $\frac{1}{2}(u + v)t$	**A1**
(a)(ii)	displacement	**A1**
(b)(i)	u = 15 sin 60° (= 13 m s^{-1})	**C1**
	t = 15 sin 60° / 9.81	**C1**
	= 1.3 s	**A1**
(b)(ii)	the force in the horizontal direction is zero	**B1**
(b)(iii)	(velocity =) 15 cos 60° = 7.5 (m s^{-1}) **or** (velocity =) 15 sin 30° = 7.5 (m s^{-1})	**A1**
(c)(i)	$p = mv$ **or** 0.40 × 7.5 **or** 0.40 × 4.3	**C1**
	Δp = 0.40 (7.5 + 4.3) = 4.7 kg m s^{-1}	**A1**
(c)(ii)	force = 4.7 / 0.12 **or** 0.40 × [(7.5 + 4.3) / 0.12] = 39 N	**A1**

37. 9702_w20_qp_23 Q: 3

	Answer	Mark
(a)	$s = \frac{1}{2}at^2$	**C1**
	57 = ½ × 9.81 × t^2 **and** t = 3.4 (s)	**A1**
(b)	horizontal distance = 41 × 3.4 = 140 m	**A1**
(c)	(displacement)^2 = 57^2 + 140^2	**C1**
	displacement = (57^2 + 140^2)$^{0.5}$ = 150 m	**A1**
(d)	straight line from the origin with positive gradient	**B1**
(e)	(1480 – m) × 0.340 = m × 41.0	**C1**
	m = 12.2 kg	**A1**
	or	
	m_c 0.34 = m_b 41 **and** m_c + m_b = 1480	**(C1)**
	m_c = (41 / 0.34)m_b (41 / 0.34)m_b + m_b = 1480 m_b = 12.2 kg	**(A1)**
(f)	acceleration (of free fall) is unchanged/is not dependent on mass	**M1**
	(so) no change (to the graph)	**A1**

38. 9702_w18_qp_21 Q: 2

	Answer	Mark
(a)	(p =) mv **or** 4.0×45 **or** 2.0×85 **or** $89v$	C1
	$(4.0 \times 45) - (2.0 \times 85) = 89\,v$ $v = 0.11\ \text{m s}^{-1}$	A1
(b)(i)	**1.** speed of approach = $47\ \text{m s}^{-1}$ **and** **2.** speed of separation = 0	A1
(b)(ii)	speed of separation less than/not equal to speed of approach **and** so inelastic collision	A1
(c)	force is equal to rate of change of momentum	B1
	force on ball (by block) equal and opposite to force on block (by ball) so rates of change of momentum are equal and opposite	B1
	or	
	force on ball (by block) equal and opposite to force on block (by ball)	(B1)
	force is equal to rate of change of momentum so rates of change of momentum are equal and opposite	(B1)

39. 9702_s17_qp_23 Q: 2

	Answer	Mark
(a)	(resultant) force is proportional/equal to the rate of change of momentum	B1
(b)(i)	change in momentum = $m(v_2 - v_1)$ $= 0.84 \times (8.8 - 4.2)$	C1
	$= 3.9\ (3.86)\ \text{kg m s}^{-1}$	A1
(b)(ii)	$F = (3.9 / 4.0) = 0.97\ (0.965)$ N	A1
(c)(i)	change in momentum for A: $0.84 \times (4.7 - 8.8) = -3.4\ (3.44)$ change in momentum for B: $0.73 \times (4.7 - 0) = 3.4\ (3.43)$	M1
	change in momentum for B is equal and opposite to A	A1
(c)(ii)	change in momentum equal (for A and B)	M1
	force is change in momentum / time and time (of collision) is the same hence force on A and B equal and opposite as for Newton's third law	A1
(c)(iii)	inelastic as relative speed of approach not equal to relative speed of separation	B1

40. 9702_w17_qp_23 Q: 3

	Answer	Mark
(a)	sum/total momentum (of system of bodies) is constant **or** sum/total momentum before = sum/total momentum after	M1
	for an isolated system/no (resultant) external force	A1
(b)(i)	$p = mv$	C1
	$(4.0 \times 6.0 \times \sin\theta) - (12 \times 3.5 \times \sin 30°) = 0$ **or** $(m_A v_A \times \sin\theta) - (m_B v_B \times \sin 30°) = 0$	M1
	$\theta = 61°$	A1

	Answer	Mark
(b)(ii)	shows the horizontal momentum component of ball A or of ball B as $(4.0 \times 6.0 \times \cos\theta)$ **or** $(12 \times 3.5 \times \cos 30°)$	**C1**
	$(4.0 \times 6.0 \times \cos 61°) + (12 \times 3.5 \times \cos 30°) = 4.0v$ so $v = 12\,(\text{m s}^{-1})$	**A1**
(b)(iii)	initial E_K $(= ½ \times 4.0 \times 12^2) = 290\ (288)$ (J)	**M1**
	final E_K $(= ½ \times 4.0 \times 6.0^2 + ½ \times 12 \times 3.5^2) = 150\ (145.5)$ (J)	**M1**
	(initial E_K > final E_K) so inelastic [both M1 marks required to award this mark]	**A1**

41. 9702_s16_qp_23 Q: 5

(a) the total momentum of a system (of colliding particles) remains constant M1

provided there is no resultant external force acting on the system/ isolated or closed system A1 [2]

(b) (i) the total kinetic energy before (the collision) is equal to the total kinetic energy after (the collision) B1 [1]

(ii) $p\ (= mv = 1.67 \times 10^{-27} \times 500) = 8.4\ (8.35) \times 10^{-25}\,\text{N s}$ A1 [1]

(iii) **1.** $mv_A \cos 60° + mv_B \cos 30°$ or $m(v_A^2 + v_B^2)^{1/2}$ B1

2. $mv_A \sin 60° + mv_B \sin 30°$ B1 [2]

(iv) 8.35×10^{-25} or $500m = mv_A \cos 60° + mv_B \cos 30°$
and
$0 = mv_A \sin 60° + mv_B \sin 30°$
or using a vector triangle C1

$v_A = 250\,\text{m s}^{-1}$ A1

$v_B = 430\ (433)\,\text{m s}^{-1}$ A1 [3]

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42. 9702_s15_qp_21 Q: 3

(a) $4.5 \times 50 - 2.8 \times M\ (= ...)$ C1

$(...) = -1.8 \times 50 + 1.4 \times M$ C1

$(M =)\ 75\,\text{g}$ A1 [3]

(b) total initial kinetic energy/KE not equal to the total final kinetic energy/KE

or relative speed of approach is not equal to relative speed of separation

so not elastic or is inelastic B1 [1]

(c) force on X is equal and opposite to force on Y (Newton III) M1

force equals/is proportional to rate of change of momentum (Newton II) M1

time of collision same for both balls hence change in momentum is the same A1 [3]

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Dynamics

Q. No.	Ans.
1	**B**
2	**B**
3	**A**
4	**A**
5	**D**
6	**A**
7	**B**
8	**D**
9	**A**
10	**A**
11	**B**
12	**A**
13	**C**
14	**A**
15	**B**
16	**A**
17	**B**
18	**C**
19	**D**
20	**B**
21	**B**
22	**B**
23	**B**
24	**D**
25	**B**
26	**C**
27	**B**
28	**B**
29	**A**
30	**B**
31	**B**
32	**D**
33	**D**
34	**D**
35	**A**
36	**D**
37	**B**
38	**B**
39	**C**
40	**A**
41	**C**
42	**A**
43	**B**
44	**D**
45	**D**
46	**B**
47	**D**
48	**A**
49	**A**
50	**D**
51	**B**
52	**B**
53	**B**
54	**A**
55	**C**
56	**B**
57	**B**
58	**B**
59	**A**
60	**B**
61	**B**
62	**D**
63	**D**
64	**A**
65	**B**
66	**C**
67	**A**
68	**A**
69	**A**
70	**D**
71	**B**
72	**C**
73	**A**
74	**A**
75	**B**
76	**D**
77	**D**
78	**B**
79	**D**
80	**B**
81	**A**
82	**D**
83	**D**
84	**D**
85	**B**
86	**D**
87	**C**
88	**A**
89	**A**
90	**A**
91	**B**
92	**C**
93	**B**
94	**B**
95	**D**
96	**B**
97	**D**
98	**A**
99	**D**
100	**B**
101	**C**
102	**A**
103	**C**
104	**B**
105	**B**
106	**A**
107	**C**
108	**C**
109	**C**
110	**B**
111	**C**
112	**B**
113	**C**
114	**B**
115	**B**
116	**C**
117	**A**
118	**C**
119	**A**
120	**C**
121	**C**
122	**C**
123	**B**
124	**C**
125	**D**
126	**D**
127	**C**
128	**C**

Q1.

1	(a)		scalar: magnitude only	B1	
			vector: magnitude and direction *(allow scalar with direction)*	B1	[2]
			(allow 1 mark for scalar has no direction, vector has direction)		
	(b)		diagram has correct shape	M1	
			with arrows in correct directions	A1	
			resultant = 13.2 ± 0.2 N *(allow 2 sig. fig)*	A2	[4]
			(for 12.8 → 13.0 and 13.4 → 13.6, allow 1 mark)		
			(calculated answer with a correct sketch, allow max 4 marks)		
			(calculated answer with no sketch – no marks)		
			Total		[6]

Q2.

4	(a)	(i)	$(p =)\ mv$	B1	
		(ii)	$E_k = \frac{1}{2}mv^2$	B1	
			algebra leading to	M1	
			$E_k = p^2/2m$	A0	[3]
	(b)	(i)	$\Delta p = 0.035\ (4.5 + 3.5)$ OR $a = (4.5 + 3.5)/0.14$	C1	
			$= 0.28$ N s $= 57.1$ m s^{-2}		
			force $= \Delta p/\Delta t\ (= 0.28/0.14)$ OR $F = ma\ (= 0.035 \times 575.1)$ (allow e.c.f.)	C1	
			$= 2.0$ N	A1	
			Note: candidate may add mg = 0.34 N to this answer, deduct 1 mark upwards	B1	[4]
		(ii)	loss $= \frac{1}{2} \times 0.035\ (4.5^2 - 3.5^2)$	C1	
			$= 0.14$ J	A1	[2]
			(No credit for $0.28^2/(2 \times 0.035) = 1.12$ J)		
	(c)		e.g. plate (and Earth) gain momentum		
			i.e. discusses a 'system'	B1	
			equal and opposite to the change for the ball		
			i.e. discusses force/momentum	M1	
			so momentum is conserved		
			i.e. discusses consequence	A1	[3]
			Total		[12]

Q3.

5	(a)	(i)	distance $= 2\pi nr$	B1	
		(ii)	work done $= F \times 2\ \pi nr$ *(accept e.c.f.)*	B1	[2]
	(b)		total work done $= 2 \times F \times 2\pi nr$	B1	
			but torque $T = 2Fr$	B1	
			hence work done $= T \times 2\pi n$	A0	[2]
	(c)		power = work done/time $(= 470 \times 2\pi \times 2400)/60)$		
			$= 1.2 \times 10^5$ W	A1	[2]
			Total		[6]

Q4.

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3	(a) (i)	$\Delta E_p = mg\Delta h$ $= 0.602 \times 9.8 \times 0.086$ $= 0.51$ J (do not allow g = 10, m = 0.600 or answer 0.50 J)	C1 A1	[2]
	(ii)	$v^2 = (2gh =) 2 \times 9.8 \times 0.086$ or $(2 \times 0.51)/0.602$ $v = 1.3$ (m s^{-1})	M1 A0	[1]
	(b)	$2 \times V = 602 \times 1.3$ (allow 600) $V = 390$ m s^{-1}	C1 A1	[2]
	(c) (i)	$E_k = ½mv^2$ $= ½ \times 0.002 \times 390^2$ $= 152$ J or 153 J or 150 J	C1 A1	[2]
	(ii)	E_k not the same/changes or E_k before impact>E_k after/E_p after so must be inelastic collision (allow 1 mark for 'bullet embeds itself in block' etc.)	 M1 A1	[2]

Q5.

2	(a)	(i)	point at which whole weight of body may be considered to act	M1 A1	[2]
		(ii)	sum of forces in any direction is zero sum of moments about any point is zero	B1 B1	[2]
	(b)		*either*: T and W have zero moment about P so F must have zero moment, i.e. pass through P *or*: if all pass through P, distance from P is zero for all forces (M1) so sum of moments about P is zero (A1)	 M1 A1	[2]
	(c)	(i)	$F\cos\alpha = T\cos\beta$	B1	[1]
		(ii)	$W = F\sin\alpha + T\sin\beta$	B1	[1]
		(iii)	$2W = 3T\sin\beta$	B1	[1]

Q6.

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3 **(a)** **(i)** $v^2 = 2as$
$1.2^2 = 2 \times a \times 1.9$ M1
$a = 0.38\ \text{m s}^{-2}$ A1 [2]

(ii) $F = ma$
$= 42 \times 0.38$ M1
$= 16\ \text{N}$ A0 [1]

(b) *power* $= Fv$ C1
$= 16 \times 1.2$
$= 19\ \text{W}$ A1 [2]

(c) **(i)** component $= 42 \times 9.8 \times \sin 2.8$ C1
$= 20.1\ \text{N}$ A1 [2]

(ii) accelerating force $= 20.1 - 16 = 4.1\ \text{N}$ C1
acceleration of trolley $= 4.1 / 42 = 0.098\ \text{m s}^{-2}$ C1
$s = \frac{1}{2}at^2$
$3.5 = \frac{1}{2} \times 0.098 \times t^2$ C1
$t = 8.5\ \text{s}$ A1 [4]

(d) *either* allows plenty of time to stop runaway trolley
or speed of trolley increases gradually
or trolley will travel faster B1 [1]
(answer must be unambiguous when read in conjunction with question)

Q7.

2 **(a)** **(i)** k is the reciprocal of the gradient of the graph C1
$k = \{32 / (4 \times 10^{-2}) = \}\ 800\ \text{N m}^{-1}$ A1 [2]

(ii) *either* energy = average force × extension *or* $\frac{1}{2}kx^2$
or area under graph line C1
energy $= \frac{1}{2} \times 800 \times (3.5 \times 10^{-2})^2$ *or* $\frac{1}{2} \times 28 \times 3.5 \times 10^{-2}$ M1
energy $= 0.49\ \text{J}$ A0 [2]

(b) **(i)** momentum before cutting thread = momentum after C1
$0 = 2400 \times V - 800 \times v$ M1
$v / V = 3.0$ A0 [2]

(ii) energy stored in spring = kinetic energy of trolleys C1
$0.49 = \frac{1}{2} \times 2.4 \times (\frac{1}{3}v)^2 + \frac{1}{2} \times 0.8 \times v^2$ C1
$v = 0.96\ \text{m s}^{-1}$ A1 [3]
(if only one trolley considered, or masses combined, allow max 1 mark)

Q8.

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2	(a)	ball moving in opposite direction (after collision)	B1		[1]
	(b) (i)	change in momentum = 1.2 (4.0 + 0.8)	C2		
		(correct values, 1 mark; correct sign {values added}, 1 mark)			
		= 5.76 N s …*(allow 5.8)*	A1		[3]
	(ii)	force = $\Delta p / \Delta t$ or $m\Delta v / \Delta t$	C1		
		= 5.76 / 0.08 or 1.2 × 4.8 / 0.08	C1		
		= 72 N	A1		[3]
	(c)	5.76 = 3.6 × V	C1		
		V = 1.6 m s^{-1}	A1		[2]
	(d)	*either* speed of approach = 4.0 m s^{-1} and			
		speed of separation = 2.4 m s^{-1}	M1		
		not equal and so inelastic	A1		
		or kinetic energy before = 9.6 J and			
		kinetic energy after collision = 4.99 J	M1		
		kinetic energy after is less / not conserved so inelastic	A1		[2]

Q9.

3	(a)	product of (magnitude of one) force and distance between forces	M1		
		reference to *either* perpendicular distance between forces			
		or line of action of forces and perpendicular distance	A1		[2]
	(b) (i)	90°	B1		[1]
	(ii)	130 = F × 0.45 *(allow e.c.f. for angle in **(i)**)*	C1		
		F = 290 N	A1		[2]
		*(allow 1 mark only if angle stated in **(i)** is not used in **(ii)**)*			

Q10.

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2 (a) 2.4 s ..... A1 [1]

(b) in **(b)** and **(c)**, allow answers as (+) or (–)
recognises distance travelled as area under graph line C1
height = (½ × 2.4 × 9.0) – (½ × 1.6 × 6.0) C1
= 6.0 m (*allow 6 m*) ..... A1 [3]
(*answer 15.6 scores 2 marks*
answer 10.8 or 4.8 scores 1 mark)

alternative solution: $s = ut - \frac{1}{2}at^2$
$= (9 \times 4) - \frac{1}{2} \times (9 / 2.4) \times 4^2$
$= 6.0$ m
(*answer 66 scores 2 marks*
answer 36 or 30 scores 1 mark)

(c) (i) change in momentum = 0.78 (9.0 + 4.2) (*allow 4.2 ± 0.2*) C1
= 10.3 N s (allow 10 N s) ..... A1 [2]

(ii) force = $\Delta p / \Delta t$ or $m\Delta v / \Delta t$ C1
= 10.3 / 3.5 / 0.08
= 2.9 N ..... A1 [2]

(d) (i) 2.9 N ..... A1 [1]

(ii) g = weight / mass C1
= 2.9 / 0.78
= 3.7 m s^{-2} ..... A1 [2]

Q11.

3 (a) *either* energy (stored)/work done represented by area under graph
or energy = <u>average</u> force × extension B1
energy = ½ × 180 × 4.0 × 10^{-2} C1
= 3.6 J ..... A1 [3]

(b) (i) *either* momentum before release is zero M1
so sum of <u>momenta</u> (of trolleys) after release is zero A1
or force = rate of change of momentum (M1)
force on trolleys equal and opposite (A1)
or impulse = change in momentum (M1)
impulse on each equal and opposite (A1) [2]

(ii) 1 $M_1V_1 = M_2V_2$ ..... B1 [1]

2 $\underline{E} = \frac{1}{2} M_1V_1^2 + \frac{1}{2} M_2V_2^2$ ..... B1 [1]

(iii) 1 $E_K = \frac{1}{2}mv^2$ and $p = mv$ combined to give M1
$E_K = p^2 / 2m$ ..... A0 [1]

2 m smaller, E_K is larger because p is the same/constant M1
so trolley B ..... A0 [1]

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Q12.

3	(a)	(i)	force is rate of change of momentum	B1	[1]
		(ii)	force on body A is equal in magnitude to force on body B (from A)	M1	
			forces are in opposite directions	A1	
			forces are of the same kind	A1	[3]
	(b)	(i)	1 $F_A = -F_B$	B1	[1]
			2 $t_A = t_B$	B1	[1]
		(ii)	$\Delta p = F_A t_A = -F_B t_B$	B1	[1]
	(c)		graph: momentum change occurs at same times for both spheres	B1	
			final momentum of sphere B is to the right	M1	
			and of magnitude 5 N s	A1	[3]

Q13.

2	(a)		no resultant force/sum of forces zero	B1	
			no resultant moment/torque/sum of moments/torques zero	B1	[2]
	(b)	(i)	each force is represented by the side of a triangle/by an arrow	M1	
			in magnitude and direction	A1	
			arrows joined, head to tail	B1	[3]
			(*could be shown on a sketch diagram*)		
		(ii)	if the triangle is 'closed' (then the forces are in equilibrium)	B1	[1]
	(c)		triangle drawn with correct shape (incorrect arrows loses this mark)	B1	
			$T_1 = 5.4 \pm 0.2\,\text{N}$	B1	
			$T_2 = 4.0 \pm 0.2\,\text{N}$	B1	[3]
	(d)		forces in strings would be horizontal	B1	
			(so) no vertical force to support the weight	B1	[2]

Q14.

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3	(a)	point where the weight of an object / gravitational force may be considered to act	M1 A1	[2]
	(b)	product of the force and the perpendicular distance (to the pivot)	B1	[1]
	(c) (i)	1. sum / net / resultant force is zero	B1	
		2. net / resultant moment is zero sum of clockwise moments = sum of anticlockwise moments	B1	[2]
	(ii)	$W \times 0.2 = 80 \times 0.5 + 70 \times 1.3$ $= 40 + 91$ $W = 655$ N (*allow 2/3 for one error in distance but 0/3 if two errors*)	C1 C1 A1	[3]
	(iii)	move pivot to left gives greater clockwise moment / smaller anticlockwise moment *or* move W to right gives smaller anticlockwise moment	(M1) (A1) (M1) (A1)	[2]

Q15.

2	(a)	resultant moment = zero / sum of clockwise moments = sum of anticlockwise moments resultant force = 0	B1 B1	[2]
	(b)	shape and orientation correct and forces labelled and arrows correct angles correct / labelled	M1 A1	[2]
	(c) (i)	$T\cos18° = W$ $T = 520 / \cos18° = 547$ N Scale diagram: ± 20 N	C1 A1	[2]
	(ii)	$R = T\sin18°$ $= 169$ N ± 20 N	A1	[1]
	(d)	θ is larger hence $\cos\theta$ is smaller, $T = W / \cos\theta$ hence T is larger	M1 A0	[1]

Q16.

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3 **(a)** weight = $m \times g$
= 130.5 × 9.81 = 1280 N — A1 [1]

(b) **(i)** $F = ma$
$T - 1280 = 130.5 \times 0.57$ — C1
$T = 1280 + 74.4 = 1350$ N — A1 [2]

(ii) 1280 N — A1 [1]

(c) $1240 - 1280 = 130.5 \times a$ — C1
$a = (-)\ 0.31\,m\,s^{-2}$ — A1 [2]

(d) **(i)** **1.** 3.5 s — A1 [1]

2. 6.5 s — A1 [1]

(ii) basic shape — M1
correct points — A1 [2]

Q17.

2 **(a)** **(i)** $v = u + at$ — C1
$= 4.23 + 9.81 \times 1.51$ — M1
$= 19.0(4)\ m\,s^{-1}$ (Allow 2 s.f.) — A0 [2]
(*Use of –g max 1/2. Use of g = 10 max 1/2. Allow use of 9.8. Allow 19 $m\,s^{-1}$*)

(ii) either $s = ut + \frac{1}{2}at^2$ (or $v^2 = u^2 + 2as$ etc.)
$= 4.23 \times 1.51 + 0.5 \times 9.81 \times (1.51)^2$ — C1
= 17.6 m (*or 17.5m*) — A1 [2]
(*Use of –g here wrong physics (0/2)*)

(b) **(i)** $F = \Delta P / \Delta t$ *need idea of change in momentum* — C1
$= [0.0465 \times (18.6 + 19)] / 12.5 \times 10^{-3}$ — C1
= 140 N — A1
(*Use of – sign max 2/4. Ignore –ve sign in answer*)
Direction: upwards — B1 [4]

(ii) $h = \frac{1}{2} \times (18.6)^2 / 9.81$ — C1
= 17.6 m *(2 s.f. –1)* — A1 [2]
(*Use of 19 $m\,s^{-1}$, 0/2 wrong physics*)

(c) *either* kinetic energy of the ball is not conserved on impact
or speed before impact is not equal to speed after hence inelastic — B1 [1]

Q18.

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3 **(a)** A body continues at rest or constant velocity unless acted on by a resultant (external) force — B1 [1]

(b) **(i)** constant velocity/zero acceleration and therefore no resultant force — M1
no resultant force (and no resultant torque) hence in equilibrium — A1 [2]

(ii) component of weight = 450 × 9.81 × sin 12° (= *917.8*) — C1
tension = 650 + 450 *g* sin12° = (650 + 917.8) — C1
= 1600 (1570) N — A1 [3]

(iii) work done against frictional force or friction between log and slope — M1
output power greater than the gain in PE / s — A1 [2]

Q19.

1 **(a)** displacement is a vector, distance is a scalar — B1
displacement is straight line between two points / distance is sum of lengths moved / example showing difference — B1 [2]
(either one of the definitions for the second mark)

(b) a body continues at rest or at constant velocity unless acted on by a resultant (external) force — B1 [1]

(c) **(i)** sum of T_1 and T_2 equals frictional force — B1
these two forces are in opposite directions — B1 [2]
(allow for 1/2 for travelling in straight line hence no rotation / no resultant torque)

(ii) **1.** scale vector triangle with correct orientation / vector triangle with correct orientation both with arrows — B1
scale given or mathematical analysis for tensions — B1 [2]

2. $T_1 = 10.1 \times 10^3 (\pm 0.5 \times 10^3)$ N — A1
$T_2 = 16.4 \times 10^3 (\pm 0.5 \times 10^3)$ N — A1 [2]

Q20.

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2 **(a)** weight = 452 × 9.81
component down the slope = 452 × 9.81 × sin 14° M1
= 1072.7 = 1070 N A0 [1]

(b) **(i)** $F = ma$ C1
$T - (1070 + 525) = 452 \times 0.13$ C1
T = 1650 (1653.76) N *any forces missing 1/3* A1 [3]

(ii) **1.** $s = ut + \frac{1}{2}at^2$ hence $10 = 0 + \frac{1}{2} \times 0.13t^2$ C1
$t = [(2 \times 10) / 0.13]^{1/2} = 12.4$ or 12 s A1 [2]

2. $v = (0 + 2 \times 0.13 \times 10)^{1/2} = 1.61$ or 1.6 m s^{-1} A1 [1]

(c) straight line from the origin B1
line down to zero velocity in short time compared to stage 1 B1
line less steep negative gradient B1
final velocity larger than final velocity in the first part – at least 2× B1 [4]

Q21.

2 **(a)** mass is the property of a body resisting changes in motion / quantity of matter in a body / measure of inertia to changes in motion B1

weight is the force due to the gravitational field/force due to gravity or gravitational force B1 [2]

Allow 1/2 for *'mass is scalar weight is vector'*

(b) **(i)** arrow vertically down through O B1
tension forces in correct direction on rope B1 [2]

(ii) **1.** weight = mg = 4.9 × 9.81 (= 48.07) C1
69 sin $\theta = mg$ C1
θ = 44.(1)° *scale drawing allow ± 2°* A1 [3]
use of cos or tan 1/3 only

2. T = 69 cos θ C1
= 49.6 / 50 N *scale drawing 50 ±2 (2/2) 50 ±4 (1/2)* A1 [2]

correct answers obtained using scale diagram or triangle of forces will score full marks
cos in ***1.*** *then sin in* ***2.*** *(2/2)*

Q22.

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2	**(a)**	force = rate of change of momentum	A1	[1]
	(b) **(i)**	horizontal line on graph from $t = 0$ to t about 2.0 s ± ½ square, $a > 0$	M1	
		horizontal line at 3.5 on graph from 0 to 2 s	A1	
		vertical line at $t = 2.0$ s to $a = 0$ or sharp step without a line	B1	
		horizontal line from $t = 2$ s to $t = 4$ s with $a = 0$	B1	[4]
	(ii)	straight line and positive gradient	M1	
		starting at (0,0)	A1	
		finishing at (2,16.8)	A1	
		horizontal line from 16.8	M1	
		from 2.0 to 4.0	A1	[5]

Q23.

3	**(a)**	the point where (all) the weight (of the body)	M1	
		is considered / seems to act	A1	[2]
	(b) **(i)**	vertical component of T (= 30 cos 40°) = 23 N	A1	[1]
	(ii)	the sum of the clockwise moments about a point equals the sum of the anticlockwise moments (about the same point)	B1	[1]
	(iii)	(moments about A): 23 × 1.2 (27.58)	M1	
		= 8.5 × 0.60 + 1.2 × W	M1	
		working to show W = 19 or answer of 18.73 (N)	A1	[3]
	(iv)	($M = W / g$ = 18.73 / 9.81 =) 1.9(09) kg	A1	[1]
	(c)	(for equilibrium) resultant force (and moment) = 0	B1	
		upward force does not equal downward force / horizontal component of T not balanced by forces shown	B1	[2]

Q24.

3	**(a)** **(i)**	the total momentum of a system (of interacting bodies) remains constant	M1	
		provided there are no resultant external forces / isolated system	A1	[2]
	(ii)	elastic: total kinetic energy is conserved, inelastic: loss of kinetic energy [allow elastic: relative speed of approach equals relative speed of separation]	B1	[1]

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(b)	**(i)**	initial mom: $4.2 \times 3.6 - 1.2 \times 1.5$ (= 15.12 – 1.8 = 13.3)	C1	
		final mom: $4.2 \times v + 1.5 \times 3$	C1	
		$v = (13.3 - 4.5) / 4.2 = 2.1\ \text{m s}^{-1}$	A1	[3]
	(ii)	initial kinetic energy $= \frac{1}{2} m_A(v_A)^2 + \frac{1}{2} m_B(v_B)^2$		
		$= 27.21 + 1.08 = 28(.28)$	M1	
		final kinetic energy = 9.26 + 6.75 = 16	M1	
		initial KE is not the same as final KE hence inelastic *provided final KE less than initial KE* [allow in terms of relative speeds of approach and separation]	A1	[3]

Q25.

2	**(a)**	mass: measure of body's resistance/inertia to changes in velocity/motion	B1	
		weight: effect of gravitational field on mass or force of gravity	B1	
		any further comment e.g. mass constant, weight varies/ weight = mg/scalar and vector	B1	[3]
	(b)	e.g. where gravitational field strength changes (change) in fluid surrounding body…. *1 each, max 2*	B2	[2]

Q26.

3	**(a)**		force x perpendicular distance	M1	
			(of the force) from the pivot	A1	[2]
	(b)		no resultant force (in any direction)	B1	
			no resultant moment (about any point)	B1	[2]
	(c)	**(i)**	correct direction in both	B1	[1]
		(ii)1	moment = 150 x 0.3 = 45 N m (1 sig. fig. -1)	A1	
		(ii)2	torque = 45 N m i.e. same is (i)	A1	
		(ii)3	45 = 0.12 x *T*	C1	
			T = 375 N	A1	[4]

Q27.

2	**(a)**	point where whole weight of body (allow mass) may be <u>considered</u> to act (do not allow 'acts')	M1 A1	**[2]**
	(b)	when CG below pivot, weight acts through the pivot (so) weight has no turning effect about pivot	B1 B1	**[2]**

Q28.

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3	(a)	change in velocity/time (taken)		B1	[1]
	(b)	velocity is a vector/velocity has magnitude & direction		B1	
		direction changing so must be accelerating		B1	[2]
	(c)	*either* 6.1 × cos35 = 4.99 N	*or* scale shown	B1	
		so no resultant vertical force	triangle of correct shape	B1	
		6.1 sin35 = 3.5 N	resultant = 3.5 ± 0.2 N	B1	
		horizontally	horizontal ± 3°	B1	[4]
		allow answer based on centripetal force:			
		resultant is centripetal force (which is horizontal)		(B1)	
		resultant is horizontal component of tension		(B1)	
		6.1 sin35 = 3.5 N		(B1)	
		horizontally		(B1)	

Q29.

4	(a)	(i)	use of tangent at time $t = 0$	B1	
			acceleration = 42 ± 4 cm s^{-2}	A1	[2]
		(ii)	use of area of loop	B1	
			distance = 0.031 ± 0.001 m	B2	[3]
			allow 1 mark if 0.031 ± 0.002 m)		
	(b)	(i)	$F = ma$	C1	
			= 0.93 × 0.42 {allow e.c.f. from (a)(i)}		
			= 0.39 N	A1	[2]
		(ii)	force reduces to zero in first 0.3 s	B1	
			then increases again in next 0.3 s	M1	
			in the opposite direction	A1	[3]

Q30.

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3	(a)		helium nucleus OR contains two protons and two neutrons	B1	[1]
	(b)		kinetic energy = $\frac{1}{2}mv^2$	C1	
			$\frac{1}{2} \times 4 \times 1.66 \times 10^{-27} \times v^2 = 1.07 \times 10^{-12}$	A1	
			$v = 1.8 \times 10^7$ m s^{-1}	A0	[2]
	(c)	(i)	sum of momenta (in any direction) is constant		
			/ total momemtum is constant	M1	
			in a closed system / no external force	A1	[2]
		(ii)	momentum of francium (= 0) = momentum of α + momentum of astatine	C1	
			$204 \times V = 4 \times 1.8 \times 10^7$	C1	
			$V = 3.5 \times 10^5$ m s^{-1}	A1	[3]
			(*nuclei incorrectly identified, 0/3*		
			nuclei correctly identified but incorrect masses, -1 each error)		
	(d)		another particle / photon is emitted	M1	
			at an angle to the direction of the α-particle	A1	[2]
			(allow 1 mark for 'Francium nucleus is not stationary')		

Q31.

3	(a)	moment:	force × <u>perpendicular</u> distance	M1	
			of force from pivot / axis / point	A1	
		couple:	(magnitude of) one force × <u>perpendicular</u> distance	M1	
			between the two forces	A1	[4]
		(*penalise the 'perpendicular' omission once only*)			
	(b)	(i)	$W \times 4.8 = (12 \times 84) + (2.5 \times 72)$	C1	
			$W = 250$ N (248 N)	A1	[2]
		(ii)	*either* friction <u>at the pivot</u> *or* small movement of weights	B1	[1]

Q32.

3	(a)	(i)	*either* sum / total momentum (of system of bodies) is constant		
			or <u>total</u> momentum before = <u>total</u> momentum after	M1	
			for an isolated system / no (external) force acts on system	A1	[2]
		(ii)	zero momentum before / after decay	M1	
			so α-particle and nucleus D must have <u>momenta</u> in opposite directions	A1	[2]
	(b)	(i)	kinetic energy = $\frac{1}{2}mv^2$	C1	
			$1.0 \times 10^{-12} = \frac{1}{2} \times 4 \times \underline{1.66} \times 10^{-27} \times v^2$	M1	
			$v = 1.7 \times 10^7$ m s^{-1}	A0	[2]
		(ii)	$1.7 \times 10^7 \times 4u = 216u \times V$	C1	
			$V = 3.1 \times 10^5$ m s^{-1}	A1	[2]
			(*accept 3.2×10^5 m s^{-1}, do not accept 220 rather than 216*)		

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(c) $(1.7 \times 10^{7})^2 = 2 \times$ *deceleration* $\times 4.5 \times 10^{-2}$ C1
deceleration / $a = 3.2 \times 10^{15}$ m s^{-2} ..... A1 [2]
(*accept calculation based on calculating* $F = 2.22 \times 10^{-11}$ *N and then use of* $F = ma$)

[Total: 10]

Q33.

3	**(a)**	force = rate of change of momentum (allow symbols if defined)		B1	[1]
	(b) **(i)**	$\Delta p = 140 \times 10^{-3} \times (5.5 + 4.0)$		C1	
		$= 1.33$ kg m s^{-1}		A1	[2]
	(ii)	force $= 1.33 / 0.04$		M1	
		$= 33.3$ N		A0	[1]
	(c) **(i)**	taking moments about B		C1	
		$(33 \times 75) + (0.45 \times g \times 25) = F_A \times 20$		C1	
		$F_A = 129$ N		A1	[3]
	(ii)	$F_B = 33 + 129 + 0.45g$		C1	
		$= 166$ N		A1	[2]

Q34.

3	**(a)**	<u>point</u> at which (whole) weight (of body) (allow mass for weight)		M1	
		appears / seems to act ... (for mass need 'appears to be concentrated')		A1	[2]
	(b) **(i)**	point C shown at centre of rectangle ± 5 mm		B1	[1]
	(ii)	arrow vertically downwards, from C with arrow starting from the same margin of error as in **(b)(i)**		B1	[1]
	(c) **(i)**	reaction / upwards / supporting / normal reaction force		M1	
		friction		M1	
		force(s) at the rod		A1	[3]
	(ii)	comes to rest with (line of action of) weight acting through rod			
		allow C vertically below the rod		B1	
		so that <u>weight</u> does not have a moment about the pivot / rod		B1	[2]

Q35.

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2	(a)	torque is the product of one of the forces and the distance between forces the perpendicular distance between the forces	M1 A1	[2]
	(b) (i)	torque = 8 × 1.5 = 12 N m	A1	[1]
	(ii)	there is a resultant torque / sum of the moments is not zero (the rod rotates) and is not in equilibrium	M1 A1	[2]
	(c) (i)	B × 1.2 = 2.4 × 0.45 B = 0.9(0) N	C1 A1	[2]
	(ii)	A = 2.4 – 0.9 = 1.5 N / moments calculation	A1	[1]

Q36.

2	(a) (i)	force is rate of change of momentum	B1	[1]
	(ii)	work done is the product of the force and the distance moved in the direction of the force	B1	[1]
	(b) (i)	$W = Fs$ **or** $W = mas$ **or** $W = m(v^2 - u^2) / 2$ **or** W = force × distance s	A1	[1]
	(ii)	$as = (v^2 - u^2) / 2$ any subject $W = mas$ hence $W = m(v^2 - u^2) / 2$ RHS represents terms of energy **or** with $u = 0$ KE = $\frac{1}{2}mv^2$	M1 M1 A1	[3]
	(c) (i)	work done = $\frac{1}{2} \times 1500 \times [(30)^2 - (15)^2]$ (=506250) distance = WD / F = 506250 / 3800 = 133 m **or** $F = ma$ $a = 2.533$ (m s^{-2}) $v^2 = u^2 + 2as$ $s = 133$ m	C1 A1 C1 A1	[2]
	(ii)	the change in kinetic energy is greater or the work done by the force has to be greater, hence distance is greater (for same force) allow: same acceleration, same time, so greater average speed and greater distance	A1	[1]

Q37.

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1	**(a)**	scalar has magnitude/size, vector has magnitude/size and direction	B1	[1]
	(b)	acceleration, momentum, weight *(–1 for each addition or omission but stop at zero)*	B2	[2]
	(c) **(i)**	horizontally: $7.5\cos 40° / 7.5\sin 50° = 5.7(45) / 5.75$ <u>not</u> 5.8 N	A1	[1]
	(ii)	vertically: $7.5\sin 40° / 7.5\cos 50° = 4.8(2)$ N	A1	[1]
	(d)	*either* correct shaped triangle	M1	
		correct labelling of two forces, three arrows and two angles	A1	
		or correct resolving: $T_2\cos 40° = T_1\cos 50°$	(B1)	
		$T_1\sin 50° + T_2\sin 40° = 7.5$	(B1)	
		$T_1 = 5.7(45)$ (N)	A1	
		$T_2 = 4.8$ (N)	A1	[4]
		(allow ± 0.2 N for scale diagram)		

Q38.

1	**(a)** **(i)**	acceleration = change in velocity / time (taken) or acceleration = rate of change of velocity		B1	[1]
	(ii)	a body continues at constant velocity unless acted on by a resultant force		B1	[1]
	(b) **(i)**	distance is represented by the area under graph		C1	
		distance = ½ × 29.5 × 3 = 44.3 m (accept 43.5 m for 29 to 45 m for 30)		A1	[2]
	(ii)	resultant force = weight – frictional force		B1	
		frictional force increases with speed		B1	
		at start frictional force = 0 / at end weight = frictional force		B1	[3]
	(iii)	**1.** frictional force increases		B1	[1]
		2. frictional force (constant) and then decreases		B1	[1]
	(iv)	**1.** acceleration = $(v_2 - v_1) / t = (20 - 50) / (17 - 15)$		C1	
		$= (-)\ 15\ \text{m s}^{-2}$		A1	[2]
		2. $W - F = ma$		C1	
		$W = 95 \times 9.81$ (= 932)		C1	
		$F = (95 \times 15) + 932 = 2400$ (2360) (2357) N		A1	[3]

Q39.

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2 **(a)** (resultant) force = rate of change of momentum / allow proportional to
or change in momentum / time (taken) B1 [1]

(b) **(i)** $\Delta p = (-)\ 65 \times 10^{-3}\ (5.2 + 3.7)$ C1

$= (-)\ 0.58\,\text{N s}$ A1 [2]

(ii) $F = 0.58 / 7.5 \times 10^{-3}$

$= 77(.3)\,\text{N}$ A1 [1]

(c) **(i)** **1.** force on the wall from the ball is equal to the force on ball from the wall M1
but in the opposite direction A1 [2]
(statement of Newton's third law can score one mark)

2. momentum change of ball is equal and opposite to momentum change
of the wall / change of momentum of ball and wall is zero B1 [1]

(ii) kinetic energy (of ball and wall) is reduced / not conserved so inelastic B1 [1]
(Allow relative speed of approach does not equal relative speed of separation.)

Q40.

2 **(a)** **(i)** accelerations (A to B and B to C) are same magnitude B1
accelerations (A to B and B to C) are opposite directions
or both accelerations are toward B B1
(A to B and B to C) the component of the weight down the slope provides
the acceleration B1 [3]

(ii) acceleration = $g \sin 15°$ C1
$s = 0 + \frac{1}{2} at^2$ $s = 0.26 / \sin 15° = 1.0$ C1

$t^2 = \frac{1.0 \times 2}{9.8 \times \sin 15°}$ $t = 0.89\,\text{s}$ A1 [3]

(iii) $v = 0 + g \sin 15 t$ or $v^2 = 0 + 2g \sin 15 \times 1.0$ C1
$v = 2.26\,\text{m s}^{-1}$ A1 [2]
(using loss of GPE = gain KE can score full marks)

(b) loss of GPE at A = gain in GPE at C or loss of KE at B = gain in GPE at C B1
$h_1 = h_2 = 0.26\,\text{m}$ or $\frac{1}{2} mv^2 = mgh$ $h_2 = 0.5 \times (2.26)^2 / 9.81 = 0.26\,\text{m}$
$x = 0.26 / \sin 30° = 0.52\,\text{m}$ A1 [2]

Q41.

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4	**(a)**	torque of a couple = <u>one</u> of the forces / a force × distance multiplied by the <u>perpendicular distance between the forces</u>	M1 A1	[2]
	(b) **(i)**	weight at P (vertically) down	B1	
		normal reaction OR contact force at (point of contact with the pin) P (vertically) up	B1	[2]
	(ii)	torque = 35 × 0.25 (or 25) × 2 = 18 (17.5) Nm	C1 A1	[2]
	(iii)	the two 35N forces are equal and opposite and the weight and the upward / contact / reaction force are equal and opposite	B1	[1]
	(iv)	not in equilibrium as the (resultant) torque is not zero	B1	[1]

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