A Level OCR Physics

Chapter 6 Forces in action

Question	Answers	Extra information	Mark	AO	Spec reference
1(a)	$P = \rho hg$ P = 136 00 × 0.018 m × 9.81 = 2401 Nm^{-2}		1	2	3.4.2c
(b)	area = $(0.13 \times 10^{-3})^2 \times \pi = 5.31 \times 10^{-8}$ m^2 $P = \frac{F}{A}$ $F = P \times A$ $F = 2400 \times 5.31 \times 10^{-8} = 1.3 \times 10^{-4}$ N		1 1	2	3.2.4b
(c)	$P = \rho hg$ $h = \frac{P}{\rho g} = \frac{2400}{1025 \times 9.81} = 0.24$ m		1	2	3.4.2c
(d)	a wider gauge needle would require more force to enter the vein/would require more force on the plunger this may actually slow down the process.		1	3	3.2.4b
2(a)	upward arrow labelled upthrust downward arrow labelled weight/mg upward arrow longer than downward arrow	must be only 2 arrows shown	1 1 1	1	3.2.1e
(b)	upthrust = weight of fluid displaced = $mg = \rho Vg$ volume of ball = $4/3\ \pi r^3 = 4/3\ \pi\ (0.02)^3 = 3.35 \times 10^{-5}$ m^3 upthrust = $1000 \times 3.35 \times 10^{-5} \times 9.81 = 0.329$ N		1 1 1	2	3.2.4 a and c
(c)	$F = ma$ $F = U - mg = 0.33 - (2.7 \times 10^{-3} \times 9.81) = 0.31$ N $a = \frac{0.31}{2.7 \times 10^{-3}} = 110$ m s^{-2}	**1** mark only if used upthrust alone	 1 1	2	3.2.1a and c
(d)	upthrust remains the same until it breaks the surface/weight remains the same throughout/drag increases as the ball accelerates		1	3	3.2.4c

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	resultant force is always acting upwards resultant force decreases as drag increases		1 1		3.2.1f
(e)	weight of ball = mg = (2.7×10^{-3} × 9.81) = 0.026 N or when floating upthrust = weight V × 1000 × 9.81 = mg = (2.7×10^{-3} × 9.81) V of displaced water = 2.7×10^{-6} m^3 fraction under water = $\frac{2.7 \times 10^{-6}}{3.35 \times 10^{-5}}$ = 0.08	or calculate fraction below water using ratio of densities	1 1 1	3	3.2.4c
3(a)	**Level 3 (5–6 marks)** Clear explanation, correct sketch graph **and** clear free body diagrams indicating relevant portions of the graph. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Some explanation, a sketch and some diagrams. *There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.* **Level 1 (1–2 marks)** Limited explanation and sketch **or** limited free body diagram and sketch. *The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.* **0 marks** No response or no response worthy of credit.	**Indicative scientific points may include:** **Explanation** • initially resultant force caused by weight • as ball accelerates the drag/air resistance increases • resultant force decreases drag in opposite direction to weight • the gradient of the velocity–time graph decreases • drag increases until it equals weight, then resultant force is zero **Sketch** • velocity–time graph axes labelled • showing initial steep gradient gradually decreasing until gradient = 0	6	3	3.2.2

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		Free body diagrams • initial with only weight/mg acting • second with two arrows: weight downwards and drag upwards; weight bigger than drag • third diagram has weight = drag			
(b)	drag = weight at terminal velocity $W = mg = 0.05 \times 9.81$ $0.4v^2 = 0.05 \times 9.81$ $v = 1.1\ \text{m s}^{-1}$		1 1	2	3.2.1c 3.2.2d
(c)	Allow any sensible suggestion here e.g. Dropping the ball through a light gate from increasing height to ensure terminal velocity reached. Measure diameter of ball to determine velocity. OR Filming fall of the ball with a grid behind and stopwatch in shot. Use the footage to identify when the ball is travelling at terminal velocity and take measurements of distance and time from footage.	just simple use of light gate – **1** mark only – need to know ball has reached terminal velocity	1 1	3	3.2.2d
(d)	Uncertainty needs to be referenced to answer to 3(c) Allow any sensible suggestions e.g. Ball may not fall through centre of light gate – meaning a smaller distance passes through light gate. Giving a higher terminal velocity OR If camera angle not in line with grid parallax errors may occur when recording the distance travelled. Depending on the angle these could record the distance as too great or too small.	**1** mark for suggestion, one for how it will affect outcome	1 1	3	3.2.2d
4(a)	(sum of) clockwise moments (about a point) = (sum of) anticlockwise moments (about a point)		1	1	3.2.3c

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	in equilibrium		1		
(b)	Clockwise moments = (0.150 × 18) + (35 × 0.360) F × 0.032 = (0.150 × 18) + (35 × 0.360) F = 480 N (478 N)	either clockwise moment correct for mark	1 1	2	3.2.3a and c
(c)	<u>perpendicular distance</u> to weight of arm and in hand decreases so F must decrease	idea of perpendicular distance needed for mark	1 1	2	3.2.3
(d)	$\sigma = \frac{F}{A}$ and $A = 22.7\times10^{-6}$ m^2 $F = 32.5\times10^{6} \times 22.7\times10^{-6} = 740$ N		1 1	2	3.4.2c
5(a)	Accept any reliable method for measuring acceleration: • including use of $v^2 = 2as$ – light gate and timing card to measure velocity and ruler to measure combinations of two light gates / one light gate etc • increasing falling mass connected to trolley • labelled diagram For accuracy • mention of friction compensated slope • falling masses taken from on top of trolley so that mass of system says constant • repeats to identify anomalies	for full marks must have at least one accuracy point	max 4	1	3.1.2a
(b)	if force ∝ acceleration then since $F = W = mg$ falling mass ∝ acceleration $\frac{\text{falling mass}}{\text{acceleration}}$ = constant	**1** for explanation **1** for at least two tests to see if constant	1 1	2	3.2.1a

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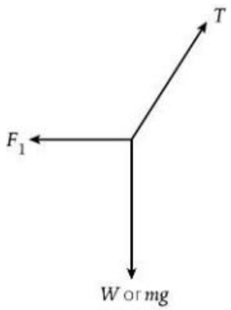
	$\frac{100}{0.69} = 145$ $\frac{200}{1.38} = 145$ $\frac{300}{2.07} = 145$				
(c)	$F = \frac{\Delta mv}{\Delta t}$ if m constant $F = \frac{m\Delta v}{\Delta t}$ or $a = \frac{\Delta v}{\Delta t}$ $F = ma$		1	2	3.5.1c
(d)	The crumple zone/seatbelts/airbags increase the time over which the momentum changes (Δt)/increase impact time This decreases the impact force		1 1	3	3.5.1d
6(a)		arrows must be labelled	1 1 1	2	3.2.1e
(b)	$T\cos\theta = mg$ or $T\sin\theta = F_1$		max 3 1	2	2.3.1d

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	$\frac{T\sin\theta}{T\cos\theta} = \frac{F_1}{mg}$ $\tan\theta = \frac{F_1}{mg}$ F_1 = tan 30 × 20 × 9.81 = 110 N (113 N) OR use of correct vector triangle and solving for F_1 correct vector triangle drawn and angle and side identified use of trig to find F_1		1 1		
(c)	acceleration proportional to displacement always in the opposite direction OR $a \propto -x$ (terms defined)		1 1	1	5.3.1c
(d)	cosine graph (negative or positive) correct max amplitude and then decreasing amplitude at least two cycles shown		1 1 1	2	5.3.1g
7(a)	$W = mg$ = 2.5 × 9.81 = 25 N (or 24.5 N) labelled arrow drawn from centre of shelf		1 1	1	3.2.1c 3.2.3d
(b)	arrow drawn horizontally to the right from point of contact of shelf and wall line of action of arrow should be the length of the shelf (same as the horizontal component of T)		1 1	2	3.2.3f
(c)	0.20 × 25 N = T sin 50 × 0.40 $T = \frac{0.2 \times 25}{\sin\theta \times 0.4}$ = 16 N	either moment identified gains mark	1 1	2	3.2.3a and c
(d)	The perpendicular distance to the tension would half but it still has to balance the same moment from the weight	Allow **1** mark for distance decreases/tension increases	1	3	3.2.3

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	The tension would double		1		
8(a)	using micrometer/Vernier callipers measure diameter several times and calculate a mean OR place ball between 2 blocks and record the distance between them	idea of measuring more than once important to ensure measuring diameter	1 1	1	3.2.2d
(b)	$V = 4/3\pi r^3$ upthrust = ρVg = 870 × $4/3\pi r^3$ × 9.81 = 4.5×10^{-3} N		1 1	2	3.2.4c
(c)	$W = mg = 8\times10^{-3} \times 9.81 = 0.078$ N $W - U = 0.074$ N or $W >> U$ or W 17 × greater so ignored		1 1	2	3.2.1c
(d)	Mark the distance travelled on the side of the glass tube each second Measure the distance the marks are apart Each distance represents the distance travelled in a second When the values are the same, this is terminal velocity		1 1	3	3.2.2d