Mark Scheme

Q1.

Question Number:	Answer	Additional Guidance	Mark
	an explanation linking: use of $P = \frac{F}{A}$ (1) **area** of piston Y is less than area of piston Z (1) (therefore) force K is less than force L (1)	accept answers in terms of work = force x distance accept reverse arguments accept K for piston Y and L for piston Z	**(3)** AO 3 2a AO 3 2b

Q2.

	Answer	Acceptable answers	Mark
(i)	 (1) air resistance (1)	upward arrow on any part of line vertical line from any point on the diagram air friction, upthrust, drag Ignore any downward arrow labelled weight or gravity	**(2)**
(ii)	Balanced (1) Zero (1)		**(2)**

Q3.

Question Number	Answer	Additional guidance	Mark
(i)	A description including any one from the following (1) **measure** a length or a specific distance related to the rubber or weights on a hanger OR with a **named device** (e.g. metre rule / stick / ruler / measuring tape) OR note position of a fixed point on rubber / weight carrier **AND** extension calculated / measured as the change in or difference between two positions or lengths or extensions (1)	evidence may be taken from additions to the diagram ignore vague statements such as see how it much it extends	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation linking graph of rubber band is non-linear / curved / not directly proportional (1) graph for unloading does not go through same points as loading (1)	 (graph for) spring would be straight (graph for) spring would only have one line / go through the same points ignore reference to returning to original shape / length	(2)

Q4.

Question Number	Answer	Additional guidance	Mark
(i)	recall (1) (P =) $\frac{E}{t}$ substitution and evaluation (1) (P=) 75 (W)	P = work done ÷ time P = $\frac{45}{0.6}$ award full marks for the correct answer without working	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	substitution into E = $\frac{1}{2} \times k \times x^2$ (1) $45 = \frac{1}{2} \times 140 \times x^2$ rearrangement (1) $(x =) \sqrt{\frac{2 \times 45}{140}}$ evaluation (1) 0.8(0) (m)	allow substitution and rearrangement in either order $x^2 = (\frac{E}{0.5k} =) \frac{2 \times 45}{140}$ $x^2 = 0.64(28571)$ accept values that round to 0.80 e.g. 0.80178 award full marks for the correct answer without working	(3)

Q5.

Question Number:	Answer	Additional Guidance	Mark
(i)	a description to include 4 of the following: • note position of pointer before current is switched on (1) • measure position of pointer when current in coil (1) • (use an ammeter to) measure current (1) • calculate the extension / stretch of the spring (1) • use force (of attraction) is proportional to extension / stretch (of spring) (1) • repeat with different currents (1)	measure length of spring before current is switched on how far nail moves calculate force from spring constant and extension calibrate spring increase the current calculate the extension of the spring using new position of pointer minus starting position of pointer is worth 3 marks	**(4)** AO 2 2

Question Number:	Answer	Additional Guidance	Mark
(ii)	select and substitute (1) (E =) ½ x 24 x 0.12^2 evaluation (1) (E =) 0.17 (J)	 ½ x 24 x 12^2 max 1 mark accept answers that round down to 0.17 e.g. 0.1728 POT error (e.g. 1728) max 1 mark award full marks for correct answer without working	**(2)** AO 2 1

Q6.

	Answer	Acceptable answers	Mark
(a)(i)	B to the left ←		**(1)**
(a)(ii)	A accelerating		**(1)**
(a)(iii)	substitution 625x 10 (1) Evaluation 6250 (N) (1)	625 x 9.8 6125 (N) give full marks for correct answer, no working	**(2)**
(b)(i)	 (1) air resistance (1)	upward arrow on any part of line vertical line from any point on the diagram air friction, upthrust, drag Ignore any downward arrow labelled weight or gravity	**(2)**
(b)(ii)	Balanced (1) Zero (1)		**(2)**

Total for marks for question = 8

Q7.

Question Number	Answer	Additional guidance	Mark
(i)	recall (1) (P =) $\frac{F}{A}$ re-arrangement and evaluation (1) A = 0.62 (m^2)	accept for recall $66\,000 = \frac{41\,000}{A}$ or $A = \frac{41\,000}{66\,000}$ allow values that round to 0.62 e.g. 0.621 award full marks for the correct answer without working	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	substitution into $P = h \times \rho \times g$ (1) 66000 = h x 1000 x 10 re-arrangement and evaluation (1) (h =) 6.6 (m)	award substitution mark if it is clear that all values have been substituted (h = $\frac{66\,000}{1\,000 \times 10}$) award full marks for the correct answer without working	(2)

Question Number	Answer	Additional guidance	Mark
(iii)	An explanation linking the pressure at the bottom of the block is greater than the pressure at the top of the block (for the same area) (1) the force on the bottom is greater than the force on the top (1)	accept in terms of weight of fluid displaced the block displaces some water weight of water displaced is less than weight of (same volume) of concrete **or** water is less dense than concrete allow the upthrust (of water) is equal to the weight of the water displaced for **2** marks	**(2)**

Question Number	Answer	Mark
(iv)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **Between 0 and 120 seconds** • the (apparent) weight of the block is less than in air (AO2) • force in the cable is less (than weight of block) (AO3) • force remains constant because upthrust is constant (AO3) • upthrust is constant because submerged volume of block is constant (AO3) • upthrust = (17.0 – 10.2) = 6.8 kN (AO3) • lifting speed = (distance for top to reach surface / time to start to emerge) = 6.6 /120 = 0.055 m/s **Between 120 and 140 seconds** • block is emerging from water (AO3) • less volume of the block remaining submerged (AO2) • upthrust is reducing (AO3) • force in the cable is increasing (AO2) • it takes 20 seconds to fully emerge from water (AO3) • height of block = lifting speed x time for top emerge = 0.055 x 20 = 1.1 m (AO3)	(6)
	140 seconds onwards • block is clear of the water (AO3) • no upthrust (from water) on the block (AO2) • force in cable is equal to weight of block (AO2) • force is constant because weight is constant (AO2) • mass of block = weight in air / 10 = 17000 / 10 = 1700 kg (AO3) • height of lorry = lifting speed x time to reach end of lift = = 0.055 x 30 s = 1.7 m (AO3) **At all times** • (speed is constant) so no force required to accelerate the block (AO2) • so force is resultant of weight and upthrust (AO2) **Other calculations are possible, eg:** • Volume of block = height x area = 1.1 x 0.62 = 0.68 m^3 • Density of block = 1700 / 0.68= 2500 kg/m^3	

Descriptor
• No awardable content
• Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
• Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
• Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Summary for guidance

Level	Mark	Additional Guidance	General additional guidance – the decision within levels e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Isolated facts with limited quantitative work e.g. identifies the change in lifting force and gives a reason why it changes.	Possible candidate responses The lifting force increases because the block is being lifted out of the water
Level 2	3–4	Additional guidance Limited explanation that includes extracting data (from either one section of the graph or elsewhere in the question) to provide a reason why the force changes	Possible candidate responses Between 120 and 140s the lifting force increases. This is because the block is being lifted out of the water and there is less upthrust.
Level 3	5–6	Additional guidance Detailed explanation that includes calculation(s) relevant to one section of the graph and correct explanation relevant to the middle section and one other section.	Possible candidate responses When underwater, the lifting force is smaller because of upthrust from the water. The upthrust = 17-10.2 = 6.8 kN The lifting force increases after 120s because it is being lifted out of the water and the upthrust is getting smaller.