Pearson Edexcel

Mark Scheme (Results)

October 2023

Pearson Edexcel International Advanced Subsidiary Level in Physics (WPH11)
Paper 01
Unit 1: Mechanics and Materials

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

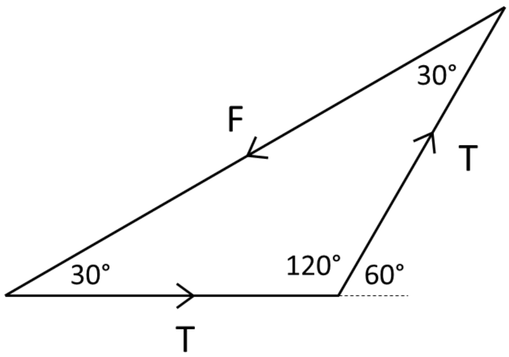
Question Number	Answer	Mark
1	**A is the correct answer** B is incorrect because displacement is a vector C is incorrect because mass is a scaler D is incorrect because velocity is a vector	**1**
2	**A is the correct answer** B is incorrect because this is an SI unit of force C is incorrect because this is an SI unit of acceleration D is incorrect because units of momentum are usually either $kg\,m\,s^{-1}$ or N s	**1**
3	**B is the correct answer** A is incorrect because Hooke's law is when force ∝ extension C is incorrect because the elastic limit relates to what happens when the deforming force is removed D is incorrect because this is the breaking stress	**1**
4	**C is the correct answer** A is incorrect because this would be stationary B is incorrect because this would be constant velocity D is incorrect because this would be a decreasing velocity	**1**
5	**C is the correct answer** A is incorrect because the force of gravity is down and the helicopter is going up B is incorrect because this includes increasing kinetic energy D is incorrect because this is the increase in kinetic energy	**1**
6	**A is the correct answer** B is incorrect because $E_k \propto v^2$ or $v \propto \sqrt{E_k}$ if $2E_k$ then $v_{new} = \sqrt{2}v$ C is incorrect because $E_k \propto v^2$ or $v \propto \sqrt{E_k}$ if $2E_k$ then $v_{new} = \sqrt{2}v$ D is incorrect because $E_k \propto v^2$ or $v \propto \sqrt{E_k}$ if $2E_k$ then $v_{new} = \sqrt{2}v$	**1**
7	**A is the correct answer** B is incorrect because useful output = 2.1 GW and total input = 2.4 + 2.1 GW C is incorrect because useful output = 2.1 GW and total input = 2.4 + 2.1 GW D is incorrect because useful output = 2.1 GW and total input = 2.4 + 2.1 GW	**1**
8	**A is the correct answer** B is incorrect because stress ∝ strain or $F/A \propto \Delta x/x$ or $\Delta x \propto x/d^2$ if $\mathbf{2}\Delta x$ then $0.5x / (0.5\,d)^2 = \mathbf{2}\,(x/d^2)$ C is incorrect because stress ∝ strain or $F/A \propto \Delta x/x$ or $\Delta x \propto x/d^2$ if $\mathbf{2}\Delta x$ then $0.5x / (0.5\,d)^2 = \mathbf{2}\,(x/d^2)$ D is incorrect because stress ∝ strain or $F/A \propto \Delta x/x$ or $\Delta x \propto x/d^2$ if $\mathbf{2}\Delta x$ then $0.5x / (0.5\,d)^2 = \mathbf{2}\,(x/d^2)$	**1**
9	**D is the correct answer** A is incorrect because the addition of vector forces on an object in equilibrium = 0 B is incorrect because the addition of vector forces on an object in equilibrium = 0 C is incorrect because the addition of vector forces on an object in equilibrium = 0	**1**

10	**B is the correct answer** A is incorrect because $W = F\cos\theta \times d$ C is incorrect because $W = F\cos\theta \times d$ D is incorrect because $W = F\cos\theta \times d$	**1**

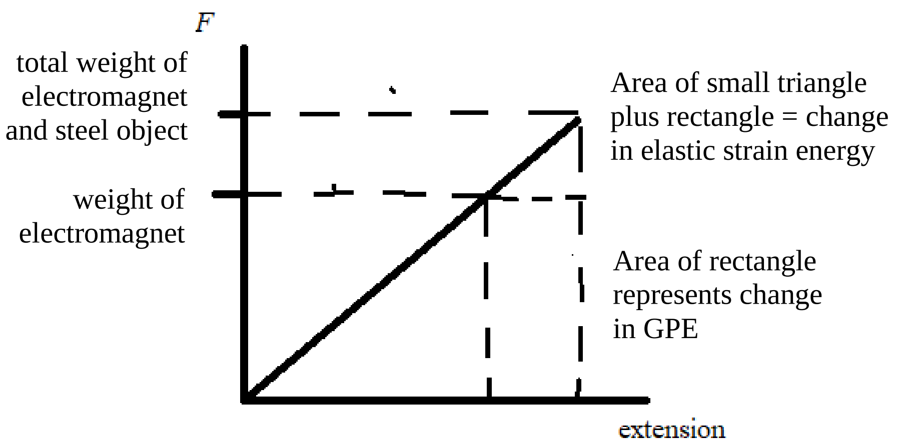
Question Number	Answer	Mark
11(a)	Use of $W = mg$ **(1)** Use of $F = ma$ **(1)** $a = 4.8 \text{ m s}^{-2}$ **(1)** <u>Example calculation</u> $W = 5.0 \times 10^6 \text{kg} \times 9.81 \text{ N kg}^{-1} = 4.91 \times 10^7 \text{ N}$ $\Sigma F = 7.3 \times 10^7 \text{ N} - 4.91 \times 10^7 \text{kg} = 5.0 \times 10^6 \text{ kg} \times a$ $a = \dfrac{2.39 \times 10^7 \text{ N}}{5.0 \times 10^6 \text{ kg}} = 4.78 \text{ m s}^{-2}$	**3**
11(b)	The mass / weight of the rocket / fuel decreases (because fuel is used up) **Or** The thrust force increases **Or** The resultant force increases **(1)**	**1**
	Total for question 11	**4**

Question Number	Answer		Mark
12(a)	Total momentum before (a collision) = total momentum after (a collision) **Or** total momentum remains constant	**(1)**	
	When no external force acts **Or** When no resultant force acts on the system **Or** In a closed / isolated system	**(1)**	**2**
12(b)(i)	Momentum is mass ×velocity **and** after the collision the mass (that is moving) is double the original value.	**(1)**	
	(because velocity is half its original value) momentum remains the same so the law is obeyed (dependent on MP1)	**(1)**	**2**
	OR		
	Initial momentum of A is equated to final momentum of A plus final momentum of B	**(1)**	
	Shows that MP1 is consistent with final velocity = half initial velocity and concludes that the law is obeyed (dependent on MP1)	**(1)**	
12(b)(ii)	(The gliders accelerate in opposite directions because) the magnetic forces are equal in size and opposite in direction **Or** (The gliders accelerate in opposite directions because) the magnetic forces form a Newton's 3rd law pair	**(1)**	
	So the velocity of one glider increases and the velocity of the other decreases (by the same amount) **Or** So the resultant force on the system is zero **Or** The magnetic forces are not external forces	**(1)**	**2**
	Total for question 12		**6**

Question Number	Answer		Mark
13(a)(i)	Use of $s = ut + ½at^2$	**(1)**	
	$t = 0.72$ (s)	**(1)**	**2**
	<u>Example calculation</u> $2.54\ \text{m} = (0 \times t) + ½ \times 9.81\ \text{m s}^{-2} \times t^2$ $t = 0.72$ s		
13(a)(ii)	Use of $s = ut + ½at^2$ with $a = 0$	**(1)**	
	$u = 25\ \text{m s}^{-1}$ [ecf from (a)(i)] [Show that value gives $25.6\ \text{m s}^{-1}$]	**(1)**	**2**
	<u>Example calculation</u> $u_H = \frac{17.89\ \text{m}}{0.72\ \text{s}} = 24.8\ \text{m s}^{-1}$		
13(b)	(If the initial velocity is increased) the horizontal (component of) velocity is larger	**(1)**	
	The vertical (component of) velocity as the ball hits the ground is not affected	**(1)**	
	(When θ is the angle to the horizontal), $\tan(\theta) = \frac{v_V}{v_H}$ so θ decreases **Or** (When θ is the angle to the vertical), $\tan(\theta) = \frac{v_H}{v_V}$ so θ increases **Or** Labelled vector diagram showing how the angle changes if initial velocity of ball is increased.	**(1)**	**3**
	Total for question 13		**7**

Question Number	Answer	Mark
14(a)	Straight arrow at least 6cm long representing *F*, with label **(1)** Vector triangle drawn with at least two sides in the triangle labelled, and *F* on the longest side. **(1)** All three arrows in correct relative directions (dependent on MP2) **(1)** *T* = 70 N (allow range of 65 to 75 N) **(1)** <u>Example vector diagram</u>  	**4**
14(b)	Use of $\Delta W = F\Delta s$ **(1)** Use of $P = W / t$ (allow **(1)** P = 28 (W), which is not equal to 35 (W), so is not consistent **(1)** [Use of $v = \frac{s}{t}$ [1] Use of $P = Fv$ [1] P = 28 W which is not equal to 35 W, so is not consistent [1]] Allow approaches that work backwards from 35W to determine time, number of repetitions, force applied or vertical distance moved. <u>Example calculation</u> ΔW = 150 N × 0.25 m = 37.5 J $P = \frac{37.5\text{ J}\times 90}{120\text{ s}}$ = 28.1 W	**3**
	Total for question 14	**7**

Question Number	Answer		Mark
15(a)	Point through which weight may be taken to act	**(1)**	**1**
15(b)(i)	Determines distance from hinge to centre of gravity of ladder (0.50 m) Use of moment = *Fx* Moment (of weight of ladder about hinge) = 27 (N m) **and** moment (of weight of board about hinge) = 22.5 (N m) **Or** combined moment (of weight of ladder and board about hinge) = 4.5 (N m) Combined moment (of the weights of the board and ladder about the hinge) is clockwise. **Or** clockwise moment is greater than anticlockwise moment The block causes a force / moment so the resultant moment (on ladder and board) is zero <u>Example calculation</u> Distance from hinge to centre of gravity of ladder = $\left(\frac{2.7\text{ m}}{2} - 0.85\text{ m}\right)$ Clockwise moment $= 54\text{ N} \times (0.50\text{ m}) = 27\text{ N m}$ Anticlockwise moment 50 N × 0.45 m = 22.5 N m	**(1)** **(1)** **(1)** **(1)** **(1)**	**5**
15(b)(ii)	Use of moment = *Fx* **and** difference in moments from (b)(i) Force = 5.6 N (ecf from(b)(i)) If no other mark scored, allow 1 mark for a force calculated using a distance of 0.80 m with a valid moment using data from the question <u>Example calculation</u> Resultant moment = 27 N m – 22.5 N m = 4.5 N m $F = \frac{4.5\text{ N m}}{0.80\text{ m}} = 5.63\text{ N}$	**(1)** **(1)**	**2**
	Total for question 15		**8**

Question Number	Answer		Mark
16(a)	They act on the same object They are not the same type of force	(1) (1)	2
16(b)(i)	Use of $\varepsilon = \frac{\Delta x}{x}$ Use of $F = k\Delta x$ **and** $\sigma = \frac{F}{A}$ Use of $E = \frac{\sigma}{\varepsilon}$ [allow a method using $E = \frac{kx}{A}$ for 3 marks] $E = 2.1 \times 10^{11}$ Pa <u>Example calculation</u> $\Delta x = 3 \times 10^{-4} \times 3.8 \text{ m} = 1.14 \times 10^{-3} \text{ m}$ $F = 2.8 \times 10^{7} \text{ N m}^{-1} \times 1.14 \times 10^{-3} \text{ m} = 3.19 \times 10^{4} \text{ N}$ $\sigma = \frac{3.19\times104 \text{ N}}{5.1\times10^{-4} \text{ m}^2} = 6.26 \times 10^{7}$ Pa $E = \frac{6.26\times10^{7} \text{Pa}}{3.0\times10^{-4}} = 2.09 \times 10^{11}$ Pa	(1) (1) (1) (1)	4
16(b)(ii)	Area under graph = elastic strain energy (can be indicated on graph) Weight of electromagnet is still exerted on cable after object falls (can be indicated on graph) So change in elastic strain energy = area under graph between total weight (of electromagnet and steel object) and weight of electromagnet (can be shown on graph or given as an algebraic equivalent using $E_{el} = \frac{1}{2}F\Delta x$) And change in gravitational potential energy of electromagnet is weight of electromagnet × change in extension (can be indicated on graph) So the change in elastic strain energy stored > change in gravitational potential energy of the electromagnet <u>Example of graph</u> 	(1) (1) (1) (1) (1)	5
	Total for question 16		**11**

Question Number	Answer		Mark
17(a)	An upwards force caused by the displacement of fluid (by an object) **Or** (a force equal and opposite to) the weight of fluid displaced (by an object)	**(1)**	**1**
17(b)(i)	Use of $\rho = \frac{m}{V}$ and $W = mg$ to calculate upthrust Use of $\Sigma F = ma$ W = 13.2 (N) <u>Example calculation</u> $U = 1.63\ \text{m}^3 \times 1.23\ \text{kg m}^{-3} \times 9.81\ \text{N kg}^{-1} = 19.67\ \text{N}$ $\Sigma F = 19.67\ \text{N} - \text{m} \times 9.81 = \text{m} \times 4.80\ \text{m s}^{-2}$ $m = \dfrac{19.7\ \text{N}}{4.80\ \text{N kg}^{-1} + 9.81\ \text{m s}^{-2}} = 1.346\ \text{kg}$ $W = 1.346\ \text{kg} \times 9.81\ \text{N kg}^{-1} = 13.20\ \text{N}$	**(1)** **(1)** **(1)**	**3**
17(b)(ii)	Density at 25 km = 0.05 kg m^{-3} (range 0.040 – 0.050 kg m^{-3}) Use of $W = mg$ **and** $\rho = m / V$ Volume required at 25 km = 27 m^3 (range 26 m^3 to 34 m^3) [show that value gives 26.5 m^3] [allow ecf from b(i)] **Or** Upthrust from a balloon of volume 50 m^3 at 25 km = 25 N (range 19.6 to 25.0 N) Valid conclusion from comparison of their calculated volume with 50 m^3 **Or** Valid conclusion from comparison of their calculated upthrust with weight of balloon <u>Example calculation</u> Upthrust required = 13.2 N = 0.05 kg m^{-3} × 9.81 N kg^{-1} × V V = 13.2 N ÷ 0.491 N m^{-3} = 26.9 m^3 26.9 m^3 < 50 m^3 so yes	**(1)** **(1)** **(1)** **(1)**	**4**

***17(c)**	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content and lines of reasoning.	

IC points	IC mark	Max linkage mark available	Max final mark
6	4	2	6
5	3	2	5
4	3	1	4
3	2	1	3
2	2	0	2
1	1	0	1
0	0	0	0

	Marks
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkages between points and is unstructured	0

Indicative content:

IC1 (When the balloon is released) upthrust greater than weight

IC2 the resultant force is upward

IC3 Velocity of balloon increases
Or balloon accelerates (upwards)

IC4 (after balloon is at maximum volume) Upthrust decreases as height increases (because density of surrounding air decreases)

IC5 Until upthrust is less than weight so there is a resultant force downwards

IC6 Velocity of balloon then decreases to zero
Or balloon then decelerates to rest.

[Ignore references to viscous drag.]

6

	Total for question 17	**14**

Question Number	Answer	Mark
18(a)	Small spherical object **Or** Spherical object moving at low speed **(1)** Laminar flow [allow non-turbulent flow] **(1)**	2
18(b)(i)	**Max 3** Initially the velocity is zero so gradient is zero **(1)** As velocity increases the gradient changes **(1)** As velocity increases, drag increases **(1)** Until terminal / constant velocity when the gradient becomes constant. **(1)** [If no other mark scored, allow 1 mark for velocity increases until terminal velocity is reached.]	3
18(b)(ii)	Determines radius of ball bearing **(1)** Determines gradient **(1)** Use of $F = 6\pi\eta rv$ **(1)** η = 0.046 (Pa s) [allow a range from 0.044 (Pa s) to 0.048 (Pa s)] **(1)** <u>Example calculation</u> Radius = $\frac{1.6\times10^{-3}\text{ m}}{2} = 8\times10^{-4}$ m Gradient = $\frac{11.5}{1.15-0.60} =$ 20.9 $v = 0.209\text{ m s}^{-1}$ $\eta = \frac{1.45\times10^{-4}\text{ N}}{6\pi\times8\times10^{-4}\text{ m}\times0.209\text{ m s}^{-1}} =$ 0.0460 Pa s	4
18(b)(iii)	At higher temperature the viscosity will be less **(1)** $F = 6\pi\eta rv$ **and** r is constant **(1)** Drag force is less (at a given speed) **Or** Drag force (at terminal velocity) is unchanged **(1)** <u>Terminal</u> velocity is greater (and ball-bearing takes less time to fall) **(1)**	4
	Total for question 18	**13**

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