Pearson Edexcel

Mark Scheme (Results)

January 2021

Pearson Edexcel International Advanced Subsidiary/ Advanced Level In Physics (WPH11)

Paper 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.

Mark scheme notes

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

For example:

(iii) Horizontal force of hinge on table top

66.3 (N) or 66 (N) **and** correct indication of direction [no ue] ✓ **1**

[Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

1. Mark scheme format

1.1 You will not see ‘wtte’ (words to that effect). Alternative correct wording should be credited in every answer unless the ms has specified specific words that must be present. Such words will be indicated by underlining e.g. ‘resonance’

1.2 Bold lower case will be used for emphasis.

1.3 Round brackets ( ) indicate words that are not essential e.g. “(hence) distance is increased”.

1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties

2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.

2.2 Incorrect use of case e.g. ‘Watt’ or ‘w’ will **not** be penalised.

2.3 There will be no unit penalty applied in ‘show that’ questions or in any other question where the units to be used have been given, for example in a spreadsheet.

2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).

2.5 Occasionally, it may be decided not to penalise a missing or incorrect unit e.g. the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.

2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. Significant figures

3.1 Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in ‘show that’ questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.

3.2 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

4. **Calculations**
   - 4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.
   - 4.2 If a 'show that' question is worth 2 marks then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.
   - 4.3 **use** of the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.
   - 4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.
   - 4.5 The mark scheme will show a correctly worked answer for illustration only.
   - 4.6 Example of mark scheme for a calculation:

<u>'Show that' calculation of weight</u>

Use of L × W × H ✓

Substitution into density equation with a volume and density ✓

Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] ✓

[If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark]

[Bald answer scores 0, reverse calculation 2/3]

Example of answer:

80 cm × 50 cm × 1.8 cm = 7200 cm^3

7200 cm^3 × 0.70 g cm^{-3} = 5040 g

5040 × 10^{-3} kg × 9.81 N/kg

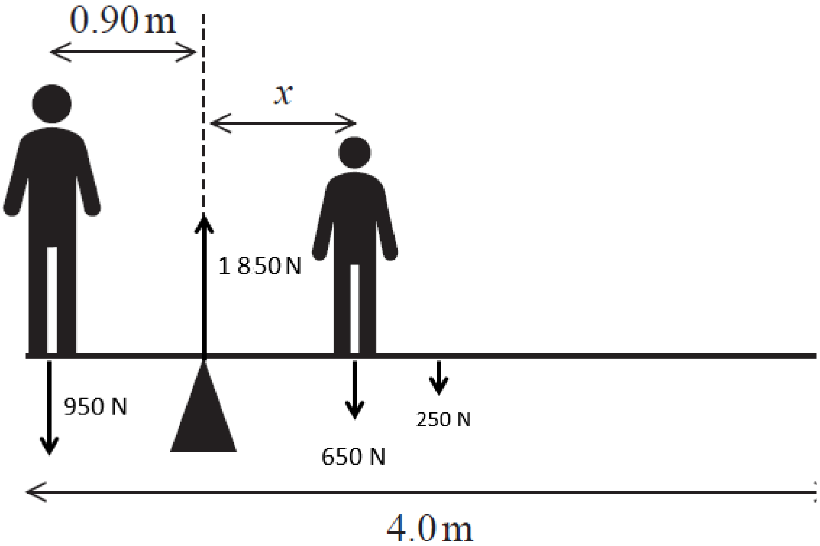
= 49.4 N

3

5. **Quality of Written Communication**
   - 5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.
   - 5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

6. **Graphs**
   - 6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.
   - 6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.
   - 6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.
   - 6.4 Points should be plotted to within 1 mm.
     - Check the two points furthest from the best line. If both OK award mark.
     - If either is 2 mm out do not award mark.
     - If both are 1 mm out do not award mark.
     - If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.
     - For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Answer	Mark
1	**C is the correct answer** A is incorrect because the velocity should be squared B is incorrect because the displacement should be doubled and the velocity squared D is incorrect because the displacement should be doubled	**(1)**
2	**C is the correct answer** A is incorrect because it takes no account of the k.e. B is incorrect because the energy dissipated would be greater than the original energy D is incorrect because the energy dissipated could not be negative	**(1)**
3	**D is the correct answer** A is incorrect because the acceleration is not positive B is incorrect because the acceleration is decreasing C is incorrect because the acceleration is constant	**(1)**
4	**B is the correct answer** A is incorrect because the graph would have a gradient of $g/2$ C is incorrect because the graph would have a gradient of $2/g$ D is incorrect because the graph would have a gradient of $1/g$	**(1)**
5	**C is the correct answer** A is incorrect because breaking stress is material property independent of dimensions B is incorrect because density is material property independent of dimensions D is incorrect because Young modulus is material property independent of dimensions	**(1)**
6	**A is the correct answer** B is incorrect because object B has greater leftward momentum than object A C is incorrect because total momentum is not the sum of the magnitudes D is incorrect because total momentum is not the sum of the magnitudes	**(1)**
7	**C is the correct answer** A is incorrect because the ball bearing is not in the oil at V B is incorrect because the ball bearing has not reached terminal velocity at W D is incorrect because the ball bearing has not reached terminal velocity at W	**(1)**
8	**C is the correct answer** A is incorrect because density is not a vector B is incorrect because kinetic energy is not a vector D is incorrect because viscosity is not a vector	**(1)**
9	**B is the correct answer** A is incorrect because the forces do act in opposite directions C is incorrect because the forces are of the same type D is incorrect because the forces do have the same magnitude	**(1)**
10	**C is the correct answer** A is incorrect because time is not speed/distance B is incorrect because time is not speed/distance D is incorrect because the powers of ten are incorrect	**(1)**

Question Number	Answer		Mark
11(a)	• Three downward arrows to show the forces of the people and the weight of the plank • Upward arrow to show reaction/contact/value force at the pivot. 	(1) (1)	2
11(b)	• Use of moment = Fx • Application of principle of moments • x = 0.89 m <u>Example of calculation</u> x = (0.9 m × 950 N − 1.1 × 250) / 650 N = 0.89 m	(1) (1) (1)	3
	Total for question 11		**5**

Question Number	Answer	Mark
12(a)	• Use of $\Delta E_{grav} = mg\Delta h$ **(1)** • Use of trigonometry to calculate Δh **(1)** • P = 180 (W) **(1)** **OR** • Use of $W = Fs$ **(1)** • Use of trigonometry to calculate component of weight along slope **(1)** • P = 180 (W) **(1)** <u>Example of calculation:</u> P = 72 kg × 9.81 N kg^{-1} × 0.51m s^{-1} × sin 30° = 180 W	3
12(b)	• Use of efficiency = useful power output/total power input **(1)** • Calculates useful power output **(1)** • Power input = 3500 W **(1)** <u>Example of calculation</u> 15 × 180 W / 0.78 = 3.46 × 10^{3} W	3
	Total for question 12	**6**

Question Number	Answer		Mark
13(a)	• Use of $v^2 = u^2 + 2as$ • Vertical component, $u_V = u \sin 35°$ • Speed of ball = 17.3 (m s^{-1}) <u>Example of calculation</u> $0 = u_v^2 - 2 \times 9.81 \text{ m s}^{-2} \times 5.0 \text{ m}$ $u_v^2 = 98.1$, $u_v = \sqrt{98.1} = 9.9 \text{ m s}^{-1}$ $u = 9.9 / \sin 35° = 17.3 \text{ m s}^{-1}$	**(1)** **(1)** **(1)**	**3**
13(b)	• Use of $u_H = u \cos \theta$ • Use of $t = s/u_H$ • Use of $s = ut + \frac{1}{2}at^2$ with $u_V = u \sin \theta$ and $a = -g$ • Height = 3.2 (m) • Comparison of result consistent with calculation of height at 22 m. <u>Example of calculation</u> Horizontal speed = 17.0 cos 35° = 13.9 m s^{-1} Time to travel 22 m = 22 ÷ 13.9 = 1.58 s Initial vertical speed = 17.0 sin 35° = 9.8 m s^{-1} Height gained in 1.58 s = $9.8 \times 1.58 - 0.5 \times 9.81 \times 1.58^2 = 3.16$ m	**(1)** **(1)** **(1)** **(1)** **(1)**	**5**
	Total for question 13		**8**

Question Number	Answer	Mark
14(a)(i)	• Use of $\rho = \frac{m}{V}$ (1) • Use of $A = \pi r^2$ (1) • Use of volume in 1 second = cross section area × speed (1) • Speed = 37.1 (m s^{-1}) (1) <u>Example of calculation</u> $\frac{V}{t} = \frac{300 \text{ kg s}^{-1}}{1030 \text{ kg m}^{-3}} = 0.291 \text{ m}^3\text{s}^{-1}$ $A = \pi \times 0.05^2 = 7.85 \times 10^{-3}$ m^2 Speed = 0.291 m^3 s^{-1}/ 7.85 × 10^{-3} m^2 = 37.1 m s^{-1}	4
14(a)(ii)	• Use of $p = mv$ (1) • Rate of change of momentum = 1.1 × 10^4 kg m s^{-2} (ecf from (a)(i)) (1) <u>Example of calculation</u> mass × speed = 300 kg ×37.1 m s^{-1} = 1.11 × 10^4 kg m s^{-2}	2
14(b)	• <u>Pump</u> applies a (forward) <u>force</u> to the <u>water</u>. (1) • By <u>Newton 3</u>, water applies an (equal and) opposite/backward force to the pump **Or** By <u>Newton 3</u>, water applies a force to the pump in the opposite direction to the (flow of) water. (1)	2
14(c)	• Initially (speed is constant because) drag force = forward force (1) • Turning on pump gives <u>resultant</u> force backwards, so boat slows. (1) • Drag force becomes less (as boat slows) until forces balance again. (1)	3
	Total for question 14	**11**

Question Number	Answer	Mark
15	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 or more	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

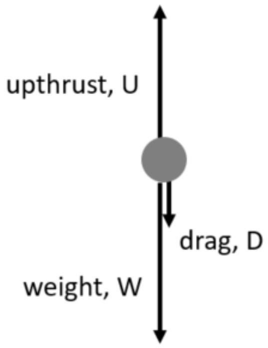
- In stage 1 the kinetic energy of the jumper is increasing
- Because work is done by gravitational force
- In stage 2 the kinetic energy of the jumper is increasing but at a decreasing rate
- Because work is done on the cord (as the cord stretches) (as well as increasing k.e.)
- In stage 3 the kinetic energy of the jumper is decreasing
- Because work is done on the cord at a greater rate than the gravitational force does work on the jumper
  Or
  He comes to rest because the total work done by gravitational forces is equal to work done stretching the bungee

6

	Total for question 15	6

Question Number	Answer	Mark
16(a)	• Micrometer (screw gauge) **Or** digital (not Vernier) calliper(s) (1)	1
16(b)(i)	• Attempt to calculate gradient (1) • Use of linear section, or tangent at origin, with use of large triangle (1) • $E = 1.2 \pm 0.05 \times 10^{11}$ Pa (1) <u>Example of calculation</u> Extending straight section to 1% 120×10^6 Pa ÷ 0.01 = 1.2×10^{11} Pa	3
16(b)(ii)	• Breaking stress read from graph (1) • Use of $A = \pi r^2$ (1) • Use of $\sigma = F/A$ (1) • $F = 2.6 \times 10^4$ N (1) <u>Example of calculation</u> Area = $\pi \times (2.525 \times 10^{-3})^2 = 2.00 \times 10^{-5}$ m^2 Force = $1\,280 \times 10^6 \times 2 \times 10^{-5} = 2.56 \times 10^4$ N	4
16(b)(iii)	• Use of area under graph = ½σε (1) • Substitution of $F = \sigma A$ and $\Delta x = \varepsilon x$ (1) • Substitution of $Ax = V$ and $\Delta W = ½ F\Delta x$ (1) <u>Example of calculation</u> Area = ½σε = ½ $(F / A)(\Delta x / x)$ = ½ $F \Delta x / (A x)$ = $\Delta W / V$	3
16(b)(iv)	• Calculation of area under graph by a valid method. (1) • Area in range 60 to 64 (MJ m^{-3}) (1) • Calculation of volume of sample (1) • Energy = 500±20 J (1) <u>Example of calculation</u> One large square = $200 \times 10^6 \times 0.01 = 2 \times 10^6$ J m^{-3} 31 large squares Volume of sample = 0.40 m × 2.0×10^{-5} m^2 = 8.0×10^{-6} m^3 Work = $31 \times 8 \times 10^{-6}$ m$^3 \times 2 \times 10^6$ J m^{-3} = 4.96×10^2 J	4
	Total for question 16	**15**

Question Number	Answer		Mark
17(a)	• Use of $\Delta F = k\Delta x$ • k = 1.9 (N cm^{-1}) <u>Example of calculation:</u> k = 15 N ÷ 8 cm = 1.875 N cm^{-1}	(1) (1)	2
17(b)	• Use of $w = mg$ • Use of force triangle and Pythagoras to find F **Or** F resolved into components • Use of trigonometry to find θ. • Use of $\Delta x = \frac{\Delta F}{k}$ • Δx = 5.4 cm (ecf from (a), "show that" value gives 5.0 cm) • θ = 32° (ecf from (a)) <u>Example of calculation:</u> $\theta = \tan^{-1}$(0.55 kg × 9.81 N kg^{-1} ÷ 8.5 N) = 32.4° $\Delta x = \sqrt{((0.55 \times 9.81)^2 + 8.5^2)}$ ÷ 1.88 = 5.37 cm	(1) (1) (1) (1) (1) (1)	6
	Total for question 17		**8**

Question Number	Answer		Mark
18(a)	• Weight **Or** W, downwards • Drag **Or** D, downwards 	(1) (1)	2
18(b)	• Use of $V = \frac{4}{3}\pi r^3$ • Use of $\rho = \frac{m}{V}$ and $W = mg$ • Upthrust = 3.06×10^{-4} (N) <u>Example of calculation</u> Volume of bead = $4/3 \times \pi \times (2.00 \times 10^{-3}\text{ m})^3 = 3.35 \times 10^{-8}\text{ m}^3$ Weight of displaced fluid = $930\text{ kg m}^{-3} \times 3.35 \times 10^{-8}\text{ m}^3 \times 9.81\text{ N kg}^{-1}$ $= 3.06 \times 10^{-4}$ N	(1) (1) (1)	3
18(c)(i)	• The flow must be laminar **Or** There must be no turbulent flow	(1)	1
18(c)(ii)	• States $D = U - W$ • Use of $F = 6\pi\eta rv$ • $v = 0.16$ (m s^{-1}) • Calculate $v_R = 0.13$ (m s^{-1}) • Comparison of v with v_R and correct conclusion (ecf from (b)) Alternative method of comparison of $F(0.13)$ with D scores full marks. <u>Example of calculation</u> $U - W = 3.06 \times 10^{-4} - 1.05 \times 10^{-5} = 2.96 \times 10^{-4}$ N $v = 2.96 \times 10^{-4}\text{ N} / (6\pi \times 4.9 \times 10^{-2}\text{ Pa s} \times 2.0 \times 10^{-3}\text{ m}) = 1.60 \times 10^{-1}\text{ m s}^{-1}$ $v_R = 10 \times 4.9 \times 10^{-2}\text{ Pa s} / (930\text{ kg m}^{-3} \times 4.0 \times 10^{-3}\text{ m}) = 1.32 \times 10^{-1}\text{ m s}^{-1}$	(1) (1) (1) (1) (1)	5
	Total for question 18		**11**