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PHYSICS
STANDARD LEVEL
PAPER 2

Candidate session number

SPECIMEN PAPER

Examination code

1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all questions.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- A clean copy of the ***Physics*** *Data Booklet* is required for this paper.
- The maximum mark for this examination paper is *[50 marks]*.

12 pages
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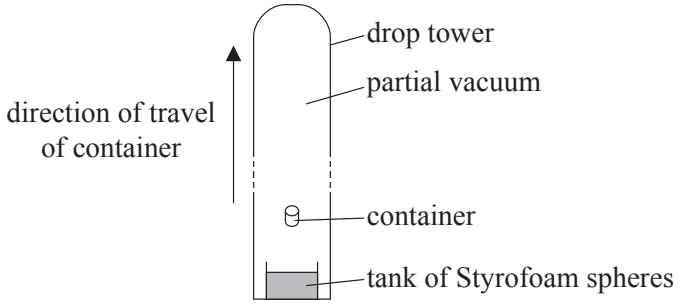
*Answer **all** questions. Write your answers in the boxes provided.*

1. In the drop tower shown, containers with experiments inside of them are fired upwards inside a vertical tower.



The container moves under the influence of gravity and eventually falls back to the bottom of the tower. Most of the air is removed from the tower so that air resistance is negligible. While in flight, the container and its contents are in free-fall.

(a) The container is fired vertically upwards with initial speed $48\,m\,s^{-1}$. Determine the time that the container is in flight. *[2]*

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(Question 1 continued)

(b) At the end of the flight, the container of total mass 480 kg falls into a tank of expanded Styrofoam (polystyrene) spheres to slow it. The container stops after moving a distance of 8.0 m in the Styrofoam. Calculate the average force that acts on the container due to the spheres. *[3]*

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(c) Outline why the experiments inside the container could be considered to be in "weightless" conditions. *[2]*

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(Question 1 continued)

(d) The tower is 120 m high with an internal diameter of 3.5 m. When most of the air has been removed, the pressure in the tower is 0.96 Pa.

(i) Determine the number of molecules of air in the tower when the temperature of the air is 300 K. *[3]*

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(ii) Outline whether the behaviour of the remaining air in the tower approximates to that of an ideal gas. *[2]*

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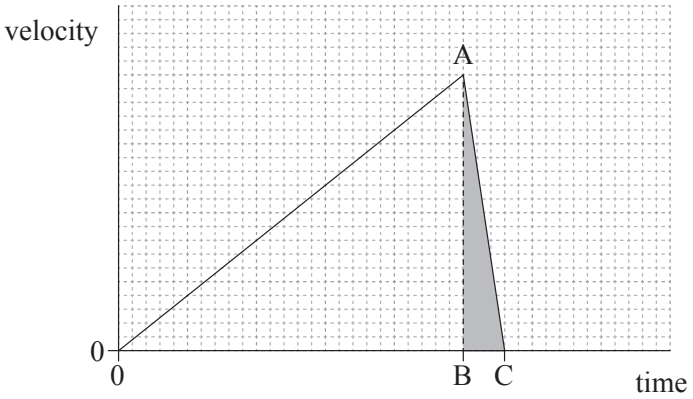
(Question 1 continued)

(e) The container can also be released from rest at the top of the tower. The graph shows how the container velocity varies with time from release with the tower in a partial vacuum.



(i) State the quantity that is represented by the shaded area ABC. *[1]*

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(ii) Air is introduced into the tower. The container is released from the top of the tower when the air in the tower is at atmospheric pressure. Using the axes in (e), sketch a graph to show how the container velocity varies with time from release when the air is at atmospheric pressure. *[3]*

2. (a) State Ohm's law. *[1]*

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(b) (i) A copper wire has a length of 0.20 km and a diameter of 3.0 mm. The resistivity of copper is $1.7 \times 10^{-8}\,\Omega\,\text{m}$. Determine the resistance of the wire. *[3]*

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(ii) A potential difference of 6.0 V is maintained across the ends of the wire. Calculate the power dissipated in the wire. *[1]*

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(iii) Explain how the flow of electrons in the wire leads to an increase in the temperature of the wire. *[3]*

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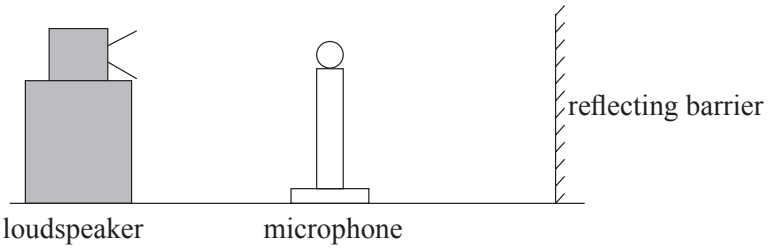
3. A loudspeaker emits sound waves of a single frequency towards a reflecting barrier.



A microphone is moved along a straight line between the loudspeaker and the barrier. A sequence of equally spaced maxima and minima of sound wave intensity is detected.

(a) Explain how the maxima and minima are formed. *[4]*

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(Question 3 continued)

(b) The microphone is moved through 1.0 m from one point of minimum intensity to another point of minimum intensity. It passes through seven points of maximum intensity as it moves. The speed of sound is 340 $m\,s^{-1}$.

(i) Calculate the wavelength of the sound waves. *[2]*

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(ii) Outline how you could use this arrangement to determine the speed of sound in air. *[3]*

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4. (a) A power station burns natural gas at a rate of $35\,kg\,s^{-1}$. The power output of the station is 750 MW and the efficiency of the station is 38 %.

(i) Calculate the energy provided by the natural gas each second. *[1]*

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(ii) Calculate the specific energy of the natural gas. State appropriate units for your answer. *[3]*

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(b) Outline why much of the world's energy is provided from fossil fuels. *[2]*

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(This question continues on the following page)

(Question 4 continued)

(c) There is a suggestion that the temperature of the Earth may increase if the use of fossil fuels is not reduced over the coming years.

(i) Explain, with reference to the enhanced greenhouse effect, why this temperature increase may occur. *[3]*

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(ii) Outline how scientists continue to attempt to resolve the climate change debate. *[1]*

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(Question 4 continued)

(d) Nuclear power stations are one way in which energy can be generated without the use of fossil fuels. One example of a nuclear fission reaction is as shown.

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{148}_{57}\mathrm{La} + {}^{85}_{35}\mathrm{Br} + x\,{}^{1}_{0}\mathrm{n}$$

(i) Identify the value of x. *[1]*

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(ii) The following data are available.

Mass of U-235 = 235.044 u
Mass of n = 1.009 u
Mass of La-148 = 148.932 u
Mass of Br-85 = 84.910 u

Determine, in MeV, the energy released when one uranium nucleus undergoes nuclear fission in the reaction in (d). *[3]*

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(Question 4 continued)

(iii) Outline, with reference to the speed of the neutrons, the role of the moderator in a nuclear reactor. *[3]*

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SPEC/4/PHYSI/SP2/ENG/TZ0/XX/M

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MARKSCHEME

SPECIMEN PAPER

PHYSICS

Standard Level

Paper 2

7 pages

General Marking Instructions

Subject Details: Physics SL Paper 2 Markscheme

Mark Allocation

Candidates are required to answer **ALL** questions. Maximum total = **[50 marks]**.

Markscheme format example:

Question			Answers	Notes	Total
4.	**b**	**ii**	the displacement and acceleration ✓ are in opposite directions ✓	*Accept **force** for **acceleration**.*	**2**

1. Each row in the "Question" column relates to the smallest subpart of the question.

2. The maximum mark for each question subpart is indicated in the "Total" column.

3. Each marking point in the "Answers" column is shown by means of a tick (✓) at the end of the marking point.

4. A question subpart may have more marking points than the total allows. This will be indicated by "**max**" written after the mark in the "Total" column. The related rubric, if necessary, will be outlined in the "Notes" column.

5. An alternative wording is indicated in the "Answers" column by a slash (/). Either wording can be accepted.

6. An alternative answer is indicated in the "Answers" column by "***OR***" on the line between the alternatives. Either answer can be accepted.

7. Words in angled brackets ‹ › in the "Answers" column are not necessary to gain the mark.

8. Words that are <u>underlined</u> are essential for the mark.

9. The order of marking points does not have to be as in the "Answers" column, unless stated otherwise in the "Notes" column.

10. If the candidate's answer has the same "meaning" or can be clearly interpreted as being of equivalent significance, detail and validity as that in the "Answers" column then award the mark. Where this point is considered to be particularly relevant in a question it is emphasized by ***OWTTE*** (or words to that effect) in the "Notes" column.

11. Remember that many candidates are writing in a second language. Effective communication is more important than grammatical accuracy.

12. Occasionally, a part of a question may require an answer that is required for subsequent marking points. If an error is made in the first marking point then it should be penalized. However, if the incorrect answer is used correctly in subsequent marking points then **follow through** marks should be awarded. When marking, indicate this by adding **ECF** (error carried forward) on the script. "ECF acceptable" will be displayed in the "Notes" column.

13. Do **not** penalize candidates for errors in units or significant figures, **unless** it is specifically referred to in the "Notes" column.

Question			Answers	Notes	Total
1.	a		use of suitable kinematic equation *eg*: $-48 = 48 - 9.81t$ ✓ 9.8 ‹s› ✓	*Award **[2]** for a bald correct answer.*	**2**
	b		$0 = 48^2 - 2a8$ so $a = 144$ ‹$\mathrm{m\,s^{-2}}$› ✓ $F_{\text{net}} = 480 \times 144$ ‹$= 6.9 \times 10^4$› ✓ average force ‹$= 6.9 \times 10^4 + 0.47 \times 10^4$› $= 7.4 \times 10^4$ ‹N› ✓		**3**
	c		reaction force is zero ✓ because object and container fall at same rate ✓		**2**
	d	i	volume $= 120 \times \pi \times (3.5)^2 = 4620$ ‹$\mathrm{m^3}$› ✓ $n = \dfrac{0.96 \times \text{volume}}{(8.31 \times 300)} = 1.78$ ✓ number of molecules $= 6.02 \times 10^{23} \times n = 1.1 \times 10^{24}$ ✓		**3**
	d	ii	‹yes› because pressure is low ✓ and temperature is high/moderate ✓		**2**
	e	i	stopping distance ‹in polystyrene›/8 m ✓	*Do not accept distance unqualified.*	**1**
	e	ii	gradient decreases as time increases before hitting the polystyrene ✓ lower maximum ✓ graph must go on longer before deceleration ✓ same total area by eye ✓	*Accept a graph reaching terminal speed.*	**3 max**

Question			Answers	Notes	Total
2.	a		V proportional to I providing temperature/physical conditions are constant ✓		1
	b	i	use of $A = \left(\frac{\pi d^2}{4}\right) = 7.1\times10^{-6}\ (\text{m}^2)$ ✓ use of $R = \frac{\rho l}{A}$ ✓ 0.48 (Ω) ✓		3
	b	ii	75 (W) ✓		1
	b	iii	electron collisions with lattice ions ✓ loss of kinetic energy of electrons ✓ increase of internal energy of lattice ions ✓		3

Question			Answers	Notes	Total
3.	a		travelling sound wave ‹is reflected at the barrier and› travels in opposite direction to original wave ✓ mention of interference/superposition ✓ minima caused by destructive interference ✓ maxima caused by constructive interference ✓ ***OR*** travelling sound wave ‹reflects at the barrier and› travels in opposite direction to original wave ✓ reflected wave superposes with original wave ✓ forming a standing wave ✓ maxima are positions of antinodes, minima are positions of nodes ✓		**4**
	b	**i**	recognition that 3.5 wavelengths are covered ✓ 0.29 ‹m› ✓		**2**
	b	**ii**	measure each position of several minima/maxima using a ruler ✓ use data to determine mean wavelength ✓ measure frequency of waves using *eg*: oscilloscope/frequency meter/electronic guitar tuner ✓ use of $c = f\lambda$ ✓	*Accept look up wave frequency or read from apparatus.*	**3 max**

Question			Answers	Notes	Total
4.	a	i	power $= \langle \frac{7.5\times10^{8}\times100}{38} = \rangle 1.97\times10^{9}$ ‹J s^{-1}› ✓		1
	a	ii	$\frac{1.97\times10^{9}}{35}$ ✓ 56 ✓ MJ kg^{-1} ✓		3
	b		plentiful supplies at present ✓ pre-existing infrastructure ✓	*Accept easily portable, easily mined.*	2
	c	i	increased proportion of greenhouse gases in atmosphere ✓ so more absorption of infrared by atmosphere ✓ and extra energy radiated back to ground ✓	*Accept any named greenhouse gas.*	3
	c	ii	improved modelling ***OR*** greater data collection ***OR*** greater international collaboration ✓		1 max
	d	i	‹235 + 1 − 148 − 85 = › 3 ✓		1
	d	ii	mass difference = ‹148.932 + 84.910 + (2 × 1.009) − 235.044› ✓ = 0.816 ‹u› ✓ 760 MeV ✓	*Allow ECF from (d)(i).*	3
	d	iii	neutrons emitted from uranium at high speed ✓ high speed neutrons do not cause fission ✓ neutrons collide with moderator atoms ✓ and therefore lose energy/speed before re-entering fuel rods ✓		3 max