

PHYSICS

HL

PAPER 2

2017 — 2024

Chapter 1	Measurements & Uncertainties	Page 1
Chapter 2	Mechanics	Page 6
Chapter 3	Thermal Physics	Page 66
Chapter 4	Oscillations & Waves	Page 104
Chapter 5	Electricity & Magnetism	Page 172
Chapter 6	Circular Motion & Gravitation	Page 235
Chapter 7	Atomic, Nuclear & Particle Physics	Page 269
Chapter 8	Energy Production	Page 323
Chapter 9	Wave Phenomena	Page 346
Chapter 10	Fields	Page 393
Chapter 11	Electromagnetic Induction	Page 425
Chapter 12	Quantum & Nuclear Physics	Page 478
	ANSWERS	Page 520

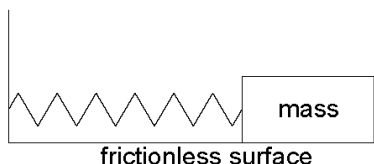
1 - (PHYSI/21_HL_Summer_2017_Q7) - Oscillations & Waves, Measurements & Uncertainties

A student is investigating a method to measure the mass of a wooden block by timing the period of its oscillations on a spring.

(a) Describe the conditions required for an object to perform simple harmonic motion (SHM). [2]

.....
.....
.....
.....

(b) A 0.52 kg mass performs simple harmonic motion with a period of 0.86 s when attached to the spring. A wooden block attached to the same spring oscillates with a period of 0.74 s.



Calculate the mass of the wooden block. [2]

.....
.....
.....
.....

(c) In carrying out the experiment the student displaced the block horizontally by 4.8 cm from the equilibrium position. Determine the total energy in the oscillation of the wooden block. [3]

.....
.....
.....
.....
.....
.....

- (d) A second identical spring is placed in parallel and the experiment in (b) is repeated. Suggest how this change affects the fractional uncertainty in the mass of the block. [3]

.....

.....

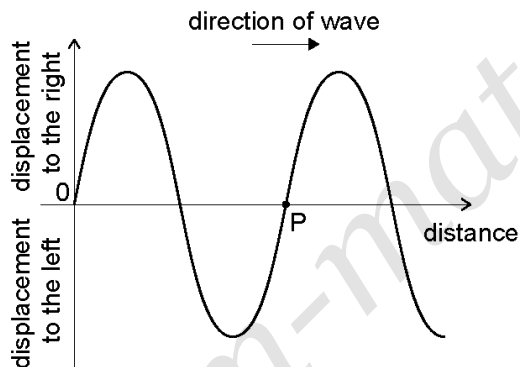
.....

.....

.....

.....

- (e) With the block stationary a longitudinal wave is made to travel through the original spring from left to right. The diagram shows the variation with distance x of the displacement y of the coils of the spring at an instant of time.



A point on the graph has been labelled that represents a point P on the spring.

- (i) State the direction of motion of P on the spring. [1]

.....

.....

- (ii) Explain whether P is at the centre of a compression or the centre of a rarefaction. [2]

.....

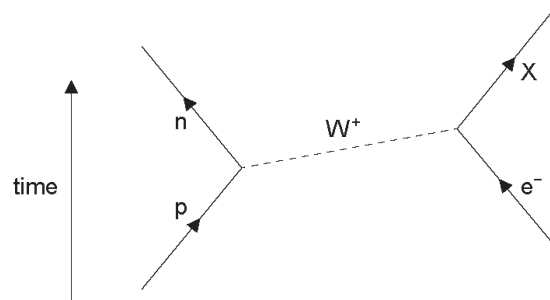
.....

.....

.....

2 - (PHYSI/20_HL_Winter_2017_Q3) - Atomic, nuclear & Particle Physics, Quantum & Nuclear Physics (ahl), Measurements & Uncertainties

(a) The Feynman diagram shows electron capture.



(i) State and explain the nature of the particle labelled X. [3]

.....

.....

.....

.....

.....

.....

(ii) Distinguish between hadrons and leptons. [2]

.....

.....

.....

.....

(b) Particles can be used in scattering experiments to estimate nuclear sizes.

(i) Outline how these experiments are carried out. [2]

.....
.....
.....
.....
.....
.....

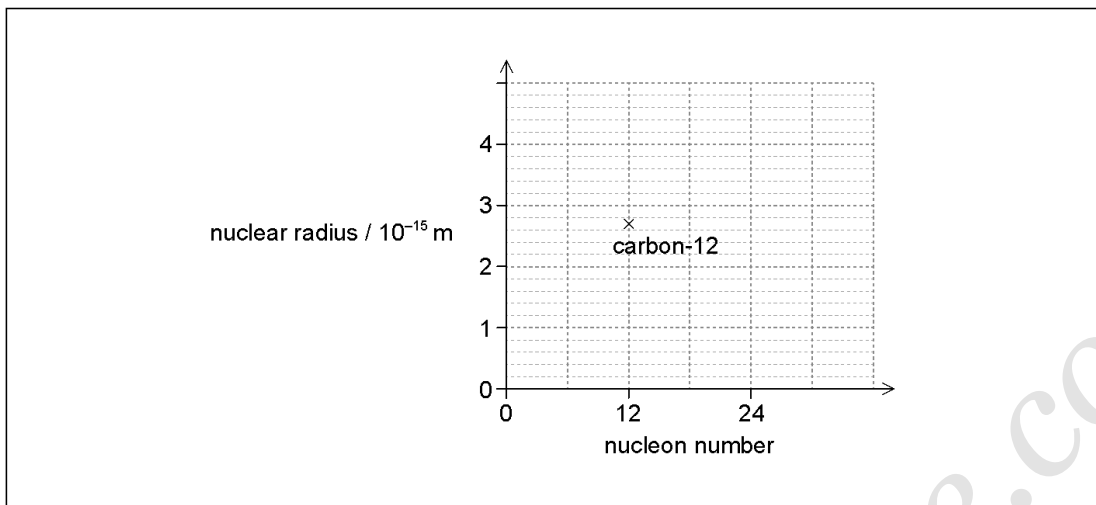
(ii) Outline why the particles must be accelerated to high energies in scattering experiments. [3]

.....
.....
.....
.....
.....
.....

(c) State and explain one example of a scientific analogy. [2]

.....
.....
.....
.....

- (d) Electron diffraction experiments indicate that the nuclear radius of carbon-12 ($^{12}_6\text{C}$) is 2.7×10^{-15} m. The graph shows the variation of nuclear radius with nucleon number. The nuclear radius of the carbon-12 is shown on the graph.



- (i) Determine the radius of the magnesium-24 ($^{24}_{12}\text{Mg}$) nucleus. [2]

.....

.....

.....

.....

.....

.....

- (ii) Plot the position of magnesium-24 on the graph. [1]
- (iii) Draw a line on the graph, to show the variation of nuclear radius with nucleon number. [2]

ANSWERS

www.exam-prepare.com

1 - (PHYSI/21_HL_Summer_2017_Q7) - Oscillations & Waves, Measurements & Uncertainties

a		acceleration/restoring force is proportional to displacement ✓ and in the opposite direction/directed towards equilibrium ✓
b		ALTERNATIVE 1 $\frac{T_1^2}{T_2^2} = \frac{m_1}{m_2}$ ✓ mass = 0.38 / 0.39 «kg» ✓ ALTERNATIVE 2 «use of $T = 2\pi\sqrt{\frac{m}{k}}$ » $k = 28$ «Nm ⁻¹ » ✓ «use of $T = 2\pi\sqrt{\frac{m}{k}}$ » $m = 0.38 / 0.39$ «kg» ✓
c		$\omega = \frac{2\pi}{0.74} = 8.5$ «rads ⁻¹ » ✓ total energy = $\frac{1}{2} \times 0.39 \times 8.5^2 \times (4.8 \times 10^{-2})^2$ ✓ = 0.032 «J» ✓
d		spring constant/k/stiffness would increase ✓ T would be smaller ✓ fractional uncertainty in T would be greater, so fractional uncertainty of mass of block would be greater ✓
e	i	left ✓
	ii	coils to the right of P move right and the coils to the left move left ✓ hence P at centre of rarefaction ✓

2 - (PHYSI/20_HL_Winter_2017_Q3) - Atomic, nuclear & Particle Physics, Quantum & Nuclear Physics (ahl), Measurements & Uncertainties

a	i	<p>«electron» neutrino ✓ it has a lepton number of 1 «as lepton number is conserved» ✓ it has a charge of zero/is neutral «as charge is conserved» OR it has a baryon number of 0 «as baryon number is conserved» ✓</p>	<p><i>Do not allow antineutrino</i></p> <p><i>Do not credit answers referring to energy</i></p>
a	ii	<p>hadrons experience strong force OR leptons do not experience the strong force ✓ hadrons made of quarks/not fundamental OR leptons are not made of quarks/are fundamental ✓ hadrons decay «eventually» into protons OR leptons do not decay into protons ✓</p>	<p><i>Accept leptons experience the weak force</i> <i>Allow "interaction" for "force"</i></p>
b	i	<p>«high energy particles incident on» thin sample ✓ detect angle/position of deflected particles ✓ reference to interference/diffraction/minimum/maximum/numbers of particles ✓</p>	<p><i>Allow "foil" instead of thin</i></p>
b	ii	<p>$\lambda \propto \frac{1}{\sqrt{E}}$ OR $\lambda \propto \frac{1}{E}$ ✓ so high energy gives small λ ✓ to match the small nuclear size ✓ Alternative 2 $E = hf$ /energy is proportional to frequency ✓ frequency is inversely proportional to wavelength/ $c = f\lambda$ ✓ to match the small nuclear size ✓ Alternative 3 higher energy means closer approach to nucleus ✓ to overcome the repulsive force from the nucleus ✓ so greater precision in measurement of the size of the nucleus ✓</p>	<p><i>Accept inversely proportional</i> <i>Only allow marks awarded from one alternative</i></p>
c		<p>two analogous situations stated ✓ one element of the analogy equated to an element of physics ✓</p>	<p><i>eg: moving away from Earth is like climbing a hill where the contours correspond to the equipotentials</i> <i>Atoms in an ideal gas behave like pool balls</i> <i>The forces between them only act during collisions</i></p>

d	i	$R = 2.7 \times 10^{-15} \times 2^{\frac{1}{3}} \checkmark$ $3.4 - 3.5 \times 10^{-15} \text{ «m» } \checkmark$	Allow use of the Fermi radius from the data booklet
d	ii	correctly plotted \checkmark	Allow ECF from (d)(i)
d	iii	<u>single smooth curve</u> passing through both points with decreasing gradient \checkmark through origin \checkmark	<p>nuclear radius / 10^{-15} m</p> <p>carbon-12</p> <p>magnesium-24</p> <p>nucleon number</p>