

Candidate forename		Candidate surname	
-------------------------------	--	------------------------------	--

Centre number						Candidate number				
--------------------------	--	--	--	--	--	-----------------------------	--	--	--	--

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
A2 GCE
G484
PHYSICS A

The Newtonian World

TUESDAY 24 JANUARY 2012: Afternoon

DURATION: 1 hour 15 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the Question Paper.

OCR SUPPLIED MATERIALS:

**Data, Formulae and Relationships Booklet
(sent with general stationery)**

OTHER MATERIALS REQUIRED:


Electronic calculator

READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS TO CANDIDATES

- **Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.**
- **Use black ink. HB pencil may be used for graphs and diagrams only.**
- **Answer ALL the questions.**
- **Read each question carefully. Make sure you know what you have to do before starting your answer.**
- **Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).**

INFORMATION FOR CANDIDATES

- **The number of marks is given in brackets [] at the end of each question or part question.**
- **The total number of marks for this paper is 60.**
- **You may use an electronic calculator.**
- **You are advised to show all the steps in any calculations.**
-  **Where you see this icon you will be awarded marks for the quality of written communication in your answer.**

This means for example you should:

- **ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;**
- **organise information clearly and coherently, using specialist vocabulary when appropriate.**

Answer ALL the questions.

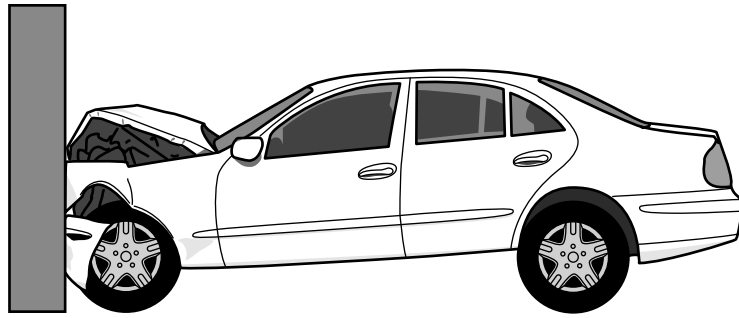
1 (a) (i) Define *linear momentum*.

[1]

(ii) Linear momentum is a vector quantity. Explain why.

[2]

- (b) The crumple zone of a car is a hollow structure at the front of the car designed to collapse during a collision. In a laboratory road-test, a car of mass 850 kg was driven into a concrete wall. A video recording of the impact showed that the car, initially travelling at 7.5 m s^{-1} , was brought to rest in 0.28 s when it hit the wall.



(i) Calculate

- 1 the deceleration of the car, assuming it to be uniform

deceleration = _____ m s^{-2} [1]

- 2 the average force exerted by the wall on the car.

force = _____ N [2]

- (ii) The crumple zone of the car is designed to absorb 0.45 MJ of energy before any distortion of the passenger cabin occurs. For this design of crumple zone, calculate the maximum speed of the car at impact.

speed = _____ m s⁻¹ [2]

- (c) In a different test, another car of mass 850 kg is travelling at a speed of 7.5 m s^{-1} . It makes a head-on collision with a stationary car of mass 1200 kg. Immediately after the impact, both cars move off together with a common speed v . Calculate this speed.

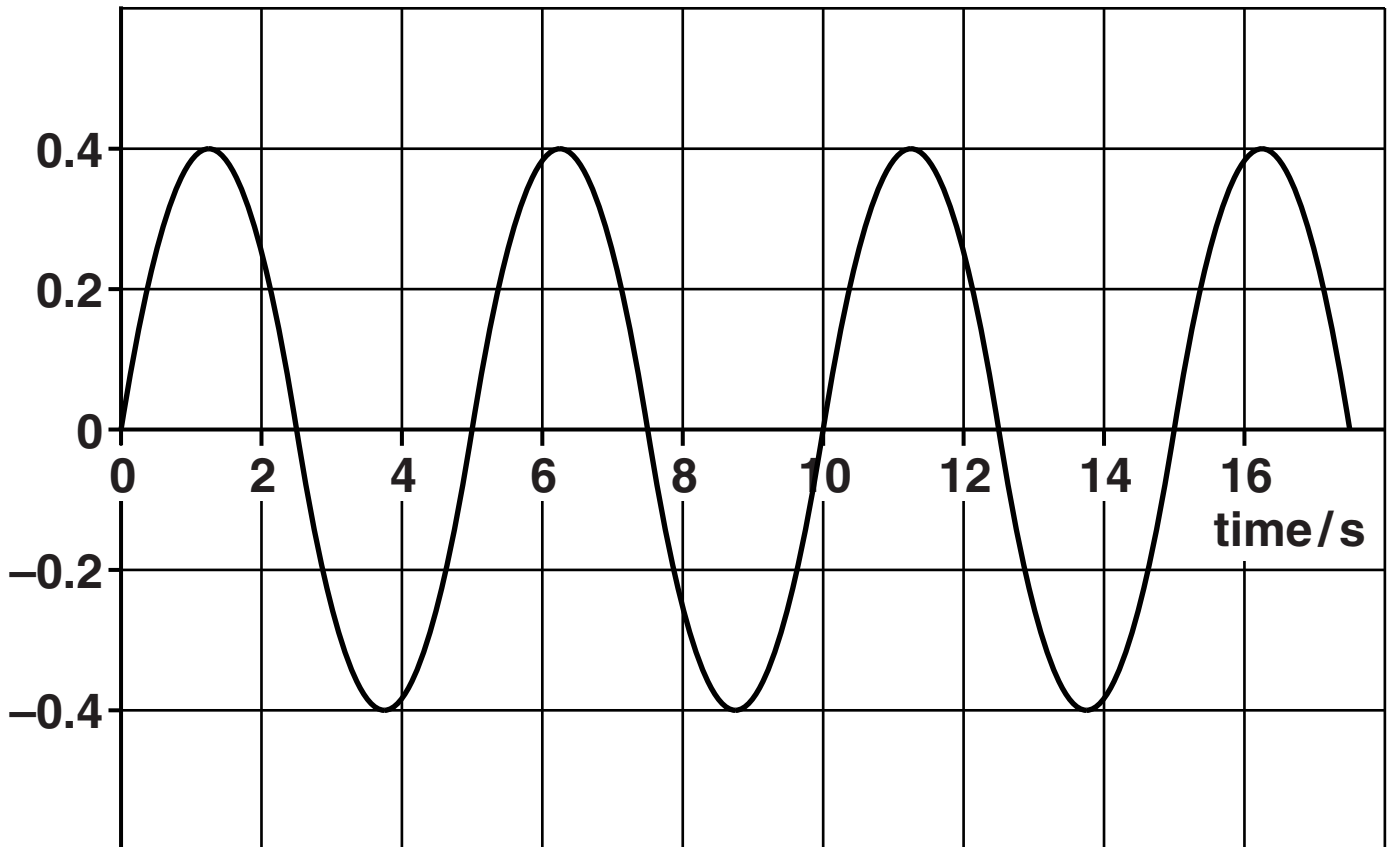
$v = \underline{\hspace{10em}} \text{ m s}^{-1}$ [2]

[Total: 10]

2 Fig. 2.1 shows a displacement against time graph for an oscillating mass.

Fig. 2.1

displacement/m



(a) Use Fig. 2.1 to determine, for the oscillations of the mass,

(i) the amplitude and period

amplitude = _____ m

period = _____ s [1]

(ii) the angular frequency, ω .

$$\omega = \underline{\hspace{10em}} \text{ rad s}^{-1} \text{ [2]}$$

(b) Mark with a cross (X) on Fig. 2.1, using a different position in each case,

(i) a point where the velocity of the mass is a maximum; label it V [1]

(ii) a point where the acceleration of the mass is zero; label it A [1]

(iii) a point where the potential energy of the mass is a minimum; label it P. [1]

(c) The cone of a loudspeaker oscillates with simple harmonic motion. It vibrates with a frequency of 2.4 kHz and has an amplitude of 1.8 mm.

(i) Calculate the maximum acceleration of the cone.

$$\text{acceleration} = \underline{\hspace{10em}} \text{ m s}^{-2} \text{ [3]}$$

- (ii) The cone experiences a mean damping force of 0.25 N. Calculate the average power needed to be supplied to the cone to keep it oscillating with a constant amplitude.

power = _____ W [3]

[Total: 12]

BLANK PAGE

- 3 (a) (i) State the name given to satellites that orbit the Earth, with a period of 1 day, above the equator.



You should use the appropriate technical term spelled correctly.

_____ [1]

- (ii) Explain why these satellites orbit above the equator.

_____ [1]

- (iii) For companies who provide a satellite TV service, suggest the main advantage of using this type of satellite.

_____ [1]

- (iv) The mass of the Earth is 6.0×10^{24} kg. Show that the radius of the orbit of a satellite with an orbital period of 1 day is about 4×10^7 m. [3]

(b) (i) State Kepler's third law.

_____ [1]

(ii) The Moon orbits the Earth with a period of 27.3 days. Use the information given in (a)(iv) to calculate the following ratio:

distance of the Moon from the Earth's centre
distance of the satellite from the Earth's centre

ratio = _____ [2]

[Total: 9]

- 4 (a) State the term used for the energy required to change a solid into a liquid.



You should use the appropriate technical term spelled correctly.

_____ [1]

- (b) (i) Define the *internal energy* of a system.

_____ [2]

- (ii) There is a change in internal energy when a mass of water at 100°C becomes an equal mass of vapour at 100°C . Explain why.

_____ [2]

- (c) (i) The air in a greenhouse has a volume of 15m^3 , a density of 1.2kgm^{-3} and a specific heat capacity of $990\text{Jkg}^{-1}\text{K}^{-1}$. Immediately after sunset, the soil is transferring thermal energy to the air at an average rate of 12W . Estimate the increase in temperature of the air in the greenhouse one hour after sunset as a result of this energy transfer from the soil.

increase in
temperature = _____ K [3]

- (ii) Suggest two possible reasons why the actual increase in temperature of the air is likely to be much lower than this estimate.

_____ [2]

[Total: 10]

5 (a) (i) State what is meant by a perfectly elastic collision.

[1]

(ii) Explain, in terms of the behaviour of MOLECULES, how a gas exerts a pressure on the walls of its container.

[4]

- (iii) Explain, in terms of the behaviour of MOLECULES, why the pressure of a gas in a container of constant volume increases when the temperature of the gas is increased.

[2]

- (b) A weather balloon is filled with helium gas. Just before take-off the pressure inside the balloon is 105 kPa and its internal volume is $5.0 \times 10^3 \text{ m}^3$. The temperature inside the balloon is 20°C . The pressure, volume and temperature of the helium gas change as the balloon rises into the upper atmosphere.

- (i) The balloon expands to a volume of $1.2 \times 10^4 \text{ m}^3$ in the upper atmosphere where the temperature inside the balloon is -30°C . Calculate the pressure inside the balloon.

pressure = _____ kPa [3]

(ii) Suggest why it is necessary to release helium from the balloon as it continues to rise.

[1]

[Total: 11]

BLANK PAGE

- 6 (a) The molar mass of hydrogen gas is $2.02 \times 10^{-3} \text{ kg mol}^{-1}$. Calculate the mass of a hydrogen molecule.

mass = _____ kg [2]

- (b) The temperature of the Earth's upper atmosphere is about 1100 K. Show that at this temperature the mean kinetic energy of an air molecule is about $2 \times 10^{-20} \text{ J}$. [2]

(c) Show that the speed of a helium atom of mass 6.6×10^{-27} kg at a temperature of 1100 K is about 2.5 km s^{-1} . [2]

(d) The *escape velocity* from the Earth is 11 km s^{-1} . The escape velocity is the minimum vertical velocity a particle must have in order to escape from the Earth's gravitational field. Explain why helium atoms still escape from the Earth's atmosphere.

[2]

[Total: 8]

END OF QUESTION PAPER

BLANK PAGE

BLANK PAGE

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.