OCR
RECOGNISING ACHIEVEMENT

Tuesday 24 January 2012 – Afternoon

A2 GCE PHYSICS A

G484 The Newtonian World

Candidates answer on the Question Paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet (sent with general stationery)

Other materials required:
- Electronic calculator

Duration: 1 hour 15 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. 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).
- Do **not** write in the bar codes.

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.
- This document consists of **12** pages. Any blank pages are indicated.

Answer **all** the questions.

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

....

.... **[1]**

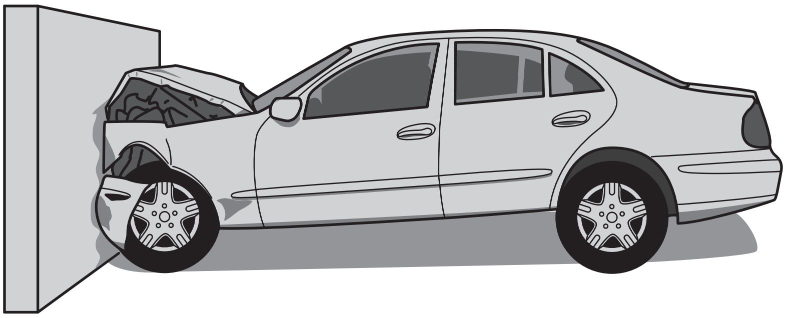
(ii) Linear momentum is a vector quantity. Explain why.

....

....

.... **[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 = ... $m\,s^{-1}$ **[2]**

[Total: 10]

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

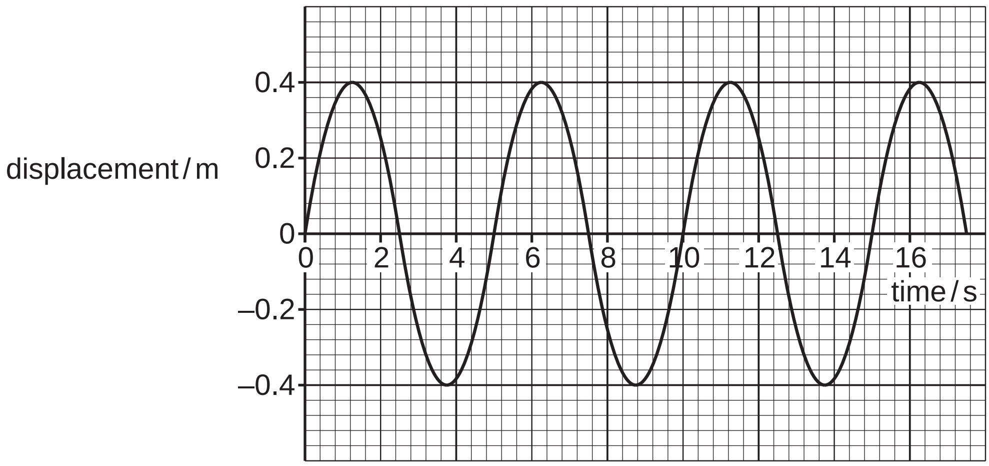


Fig. 2.1

(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.

ω = ... rad s^{-1} **[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.

acceleration = ... m s^{-2} **[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]

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:

$$\frac{\text{distance of the Moon from the Earth's centre}}{\text{distance of the satellite from the Earth's centre}}$$

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 15 m^3, a density of 1.2 $kg\,m^{-3}$ and a specific heat capacity of 990 $J\,kg^{-1}\,K^{-1}$. Immediately after sunset, the soil is transferring thermal energy to the air at an average rate of 12 W. 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 $5.0 \times 10^3\,m^3$. 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 $1.2 \times 10^4\,m^3$ 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]

Question 6 is on page 10.

6 **(a)** The molar mass of hydrogen gas is 2.02×10^{-3} 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 2×10^{-20} 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.

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....

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....

.... **[2]**

[Total: 8]

END OF QUESTION PAPER