OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS B (ADVANCING PHYSICS) **2861**

Understanding Processes

Friday **9 JUNE 2006** Morning 1 hour 30 minutes

Candidates answer on the question paper.
Additional materials:
Data, Formulae and Relationships Booklet
Electronic calculator
Ruler (cm/mm)

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
- Read the questions carefully and make sure you know what you have to do before starting your answer.
- Show clearly the working in all calculations and give answers to only a justifiable number of significant figures.

INFORMATION FOR CANDIDATES

- You are advised to spend about 20 minutes on **Section A**, 40 minutes on **Section B** and 30 minutes on **Section C**.
- The number of marks is given in brackets [ ] at the end of each question or part question.
- There are four marks available for the quality of written communication in **Section C**.
- The values of standard physical constants are given in the Data, Formulae and Relationships Booklet. Any additional data required are given in the appropriate question.

FOR EXAMINER'S USE		
Section	**Max.**	**Mark**
A	**20**	
B	**40**	
C	**30**	
TOTAL	**90**	

This question paper consists of 23 printed pages and 1 blank page.

Section A

Answer **all** the questions.

1 Here are three graphs representing different features of the same accelerated motion.

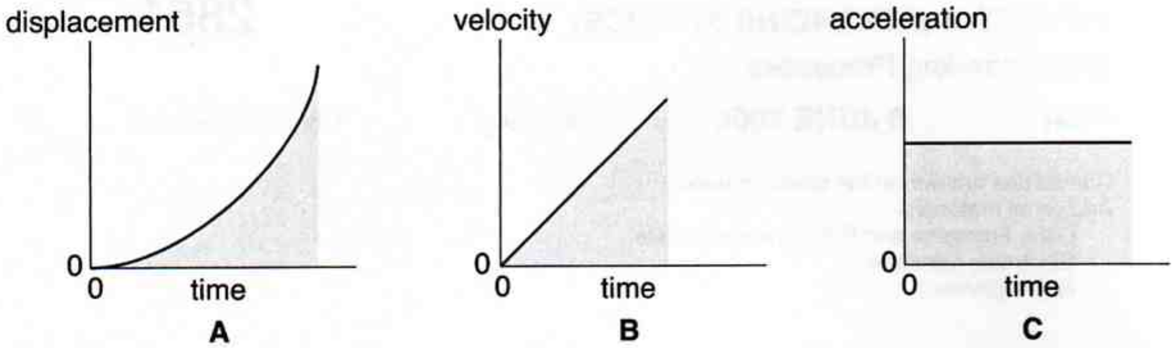

Fig. 1.1

In which graph, **A**, **B**, or **C**, in Fig. 1.1, does

(a) the gradient represent the acceleration

answer ....[1]

(b) the gradient represent the velocity

answer ....[1]

(c) the shaded area represent the distance travelled?

answer ....[1]

2 This question is about a car attempting an overtaking manoeuvre.

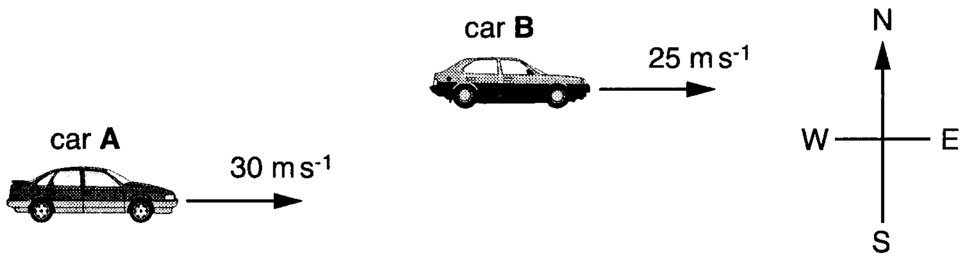

Fig. 2.1

Fig. 2.1 shows two cars travelling in an easterly direction.
Car **A** is attempting to overtake car **B** on a straight, level road.

(a) Calculate the magnitude and direction of the relative velocity of approach of car **A** to car **B**, as seen from car **B**.

magnitude = ... m s^{-1} direction ....[2]

(b) At the instant shown in Fig. 2.1, car **A** is still some distance behind car **B**.
In order to complete the overtaking safely, car **A** must move forwards a distance of 35 m relative to car **B**.

Using your answer to **(a)**, calculate how long it will take for car **A** to reach this relative position.

time = ... s [1]

(c) Calculate the distance moved by car **B** in this time.

distance = ... m [1]

For Examiner's Use

3 Light emitted from a laser has wavelength 350 nm.

(a) Show that the energy of a photon of this light is 5.7×10^{-19} J.

the Planck constant $h = 6.6 \times 10^{-34}$ J s
velocity of light $c = 3.0 \times 10^{8}$ m s^{-1}

[2]

(b) Each pulse of light from the laser lasts for only 1.2×10^{-13} s.

The power delivered in a pulse is 8.0×10^{4} W.

Calculate the number of photons in a single pulse.

number = ... [2]

4 A stone is dropped down a well which is 6.80 m deep.

The time from releasing the stone to hearing the sound of it hitting the bottom of the well is 1.20 s.

(a) A student calculates the time for the stone to reach the bottom of the well and finds that it is less than 1.20 s.

Carry out the calculation to show that the time is less than 1.20 s.
Ignore any effects of air resistance.
Give your answer to **three** significant figures.

$g = 9.81\ \text{m s}^{-2}$

time = ... s [2]

(b) The student realises that the difference between these times is the time it takes for the sound caused by the stone hitting the bottom to travel back up the well. This allows him to estimate the velocity of sound in the well.

Calculate the velocity of sound in the well.

velocity of sound = ... m s^{-1} [2]

5 When coherent light of a single wavelength passes through two narrowly spaced slits, an interference pattern is produced on a distant screen.

The fringe separation x in the pattern is given by the expression

$$x = \frac{\lambda L}{d}$$

where λ is the wavelength of the light
d is the slit separation
and L is the distance between the slits and the screen.

Here is a list of four graphs that could be plotted relating fringe separation x and slit separation d, with λ and L constant.

A x against d **B** x against d^2 **C** x against $\frac{1}{d}$ **D** x against $\frac{1}{d^2}$

Write down the letter (**A**, **B**, **C** or **D**) of the graph you would plot to obtain a straight line through the origin.

answer ....[1]

For Examiner's Use

6 A projectile is launched horizontally at a speed of $0.5\,m\,s^{-1}$ above the surface of the Moon.

The velocity of the projectile, at equal time intervals, is represented in magnitude and direction by the arrows shown in Fig. 6.1.

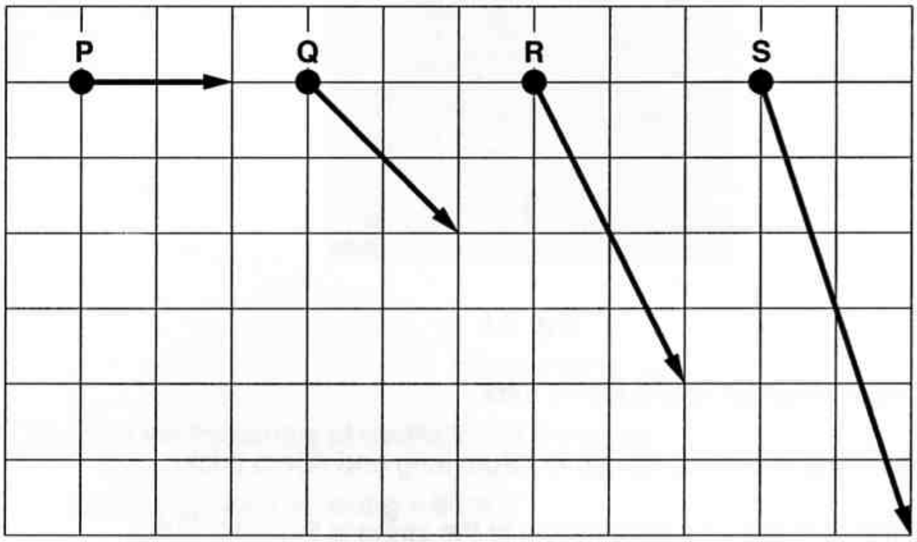

Fig. 6.1

(a) **(i)** Construct arrows on the diagram to represent the **vertical** component of velocity for each of the vectors **Q**, **R** and **S**. [1]

(ii) The grid on the diagram is drawn to the scale: 1 division represents $0.25\,m\,s^{-1}$.

Complete the table below.

velocity vector	**P**	**Q**	**R**	**S**
vertical component of velocity / $m\,s^{-1}$	0			

[1]

(b) The velocity vectors of the projectile are shown at 0.3 s intervals.

Using the information from **(a)**, calculate the acceleration due to gravity on the Moon.

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

[Section A Total: 20]

[Turn over

Section B

7 Fig. 7.1 is a photograph of the world's smallest guitar, created using nanotechnology.

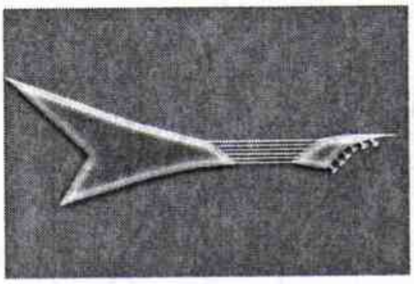

Fig. 7.1

Each string of the nanoguitar is 120 atoms thick.

(a) The longest string of the nanoguitar is 25 μm long and 40 nm thick.

Show that the diameter of a single atom in the string is 3.3×10^{-10} m.

[1]

(b) Fig. 7.2 represents one of the strings from the guitar.

Fig. 7.2

(i) Draw on the diagram the standing wave representing the lowest frequency oscillation produced by the vibrating string.
Label the positions of any displacement nodes and antinodes with the letters **N** and **A** respectively. [2]

(ii) Calculate the wavelength of this standing wave. Show your reasoning.

length of string = 25 μm

wavelength = ... m [2]

(iii) Calculate the frequency of oscillation of the string.

velocity of wave on string = 60 m s^{-1}

frequency = ... Hz [2]

(iv) Suggest **two** reasons why we would not be able to hear the note produced by the oscillating string.

[2]

[Total: 9]

[Turn over

8 The frontal area A of a road vehicle is a major factor affecting the drag force on the vehicle when moving.
As can be seen in Fig. 8.1, the frontal areas of different road vehicles vary considerably.

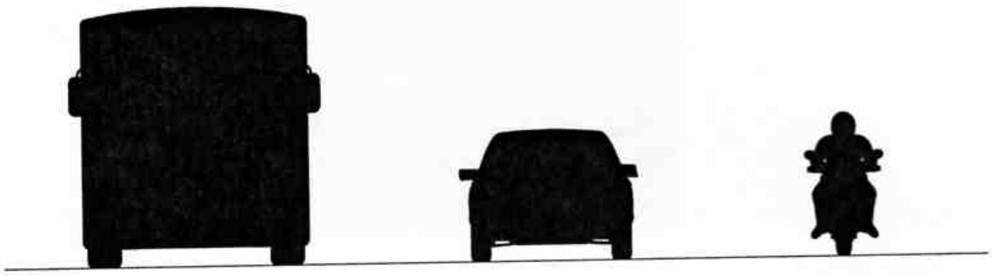

Fig. 8.1

The drag force F acting on a vehicle moving at velocity v through **still** air is given by the expression

$$F = \frac{1}{2}k\rho A v^2$$

where k is the shape constant depending only on the shape of the vehicle, ρ is the density of the air, and A is the frontal area of the car.

(a) **(i)** A car of frontal area $A = 2.5\,\text{m}^2$, and shape constant $k = 0.4$, is travelling at a steady speed of $20\,\text{m}\,\text{s}^{-1}$ in still air.

Calculate the drag force F acting on the car.
density of air $\rho = 1.2\,\text{kg}\,\text{m}^{-3}$

$F =$ .... N [2]

(ii) In a more up-to-date model of the car, the shape constant k has been reduced by 9%, from k to $0.91k$, but this has only been achieved at the expense of an increase in the frontal area of 7%, from A to $1.07A$.

Show that the drag force on this car, travelling at $20\,\text{m}\,\text{s}^{-1}$ through still air, is about 3% less than on the first car.

[2]