General Certificate of Education
June 2007
Advanced Subsidiary Examination

APPLYING MATHEMATICS
Paper 1

UOM4/1

Monday 21 May 2007 9.00 am to 10.00 am

For this paper you must have:
- an 8-page answer book
- a clean copy of the Data Sheet (enclosed)
- a graphics calculator
- a ruler.

Time allowed: 1 hour

Instructions
- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- The *Examining Body* for this paper is AQA. The *Paper Reference* is UOM4/1.
- Answer **all** questions.
- All necessary working should be shown; otherwise marks for method may be lost.
- The **final** answer to questions requiring the use of a calculator should normally be given to three significant figures.
- You may **not** refer to the copy of the Data Sheet that was available prior to this examination. A clean copy is available for your use.

Information
- The maximum mark for this paper is 30.
- The marks for questions are shown in brackets.

Answer **all** questions.

Use **Watch your speed** *on the Data Sheet.*

1 A sine wave of the form $y = \sin nt°$ has a period of 0.1 seconds.

(a) Write down its frequency (number of waves in unit time). *(1 mark)*

(b) State the value of n. *(1 mark)*

(c) How would the wave $y = \cos nt°$ differ from the wave $y = \sin nt°$? *(1 mark)*

2 A siren on a police car has a frequency of 1100 Hz. Sound travels through air at approximately $330\,\text{m}\,\text{s}^{-1}$.

(a) Find the wavelength of the sound waves if both the police car and observer are stationary. *(2 marks)*

(b) If the observer is stationary and the police car is moving **towards** the observer at a speed of $30\,\text{m}\,\text{s}^{-1}$, find:

(i) the apparent wavelength of the sound waves; *(2 marks)*

(ii) the apparent frequency of the sound waves; *(2 marks)*

(iii) the difference between the frequency of the transmitted wave and that received by the observer. *(1 mark)*

3 (a) Show that a speed of 45 mph is $20.1\,\text{m}\,\text{s}^{-1}$ to three significant figures. *(2 marks)*

(b) The article states that, for speed cameras, the difference in frequency, f_{diff}, that the camera measures is given by

$$f_{\text{diff}} = 2\frac{v_{\text{car}}}{c}f$$

(i) For the case of a car travelling **away** from a speed camera at 45 mph show that f_{diff} expressed as a fraction of the transmitted frequency is 1.34×10^{-7}. *(3 marks)*

(ii) Find f_{diff} in Hz when the frequency of waves transmitted from this speed camera is 24 GHz. *(2 marks)*

4 Another speed camera transmits radar waves with a frequency of 35 GHz. It detects a difference in frequency, f_{diff}, of 4000 Hz when a car is travelling **away** from the camera.

The speed limit on the stretch of road is 40 mph.

Would the motorist be prosecuted for speeding?
Show calculations to support your answer. *(5 marks)*

5 Because speed cameras are positioned to the side of the road, the speed of a car as measured by the camera is a fraction of its actual speed given by $v_{\text{car}} = v_{\text{actual}} \cos\theta$. The positioning of the camera affects $\cos\theta$.

A camera is positioned so that the point on which it is focused is 10 metres away along the line of travel of the car and the sideways displacement of the camera is 2.5 metres.

(a) Show that $\dfrac{v_{\text{car}}}{v_{\text{actual}}} = 0.970$. *(2 marks)*

(b) For this camera position find the angle θ. *(2 marks)*

6 (a) Sketch a graph of $y = \cos\theta$ for $0° \leqslant \theta \leqslant 90°$.
Show clearly intercepts with both axes. *(2 marks)*

(b) Use your sketch to explain why the "cosine error" is always to the advantage of the motorist. *(2 marks)*

END OF QUESTIONS

There are no questions printed on this page