



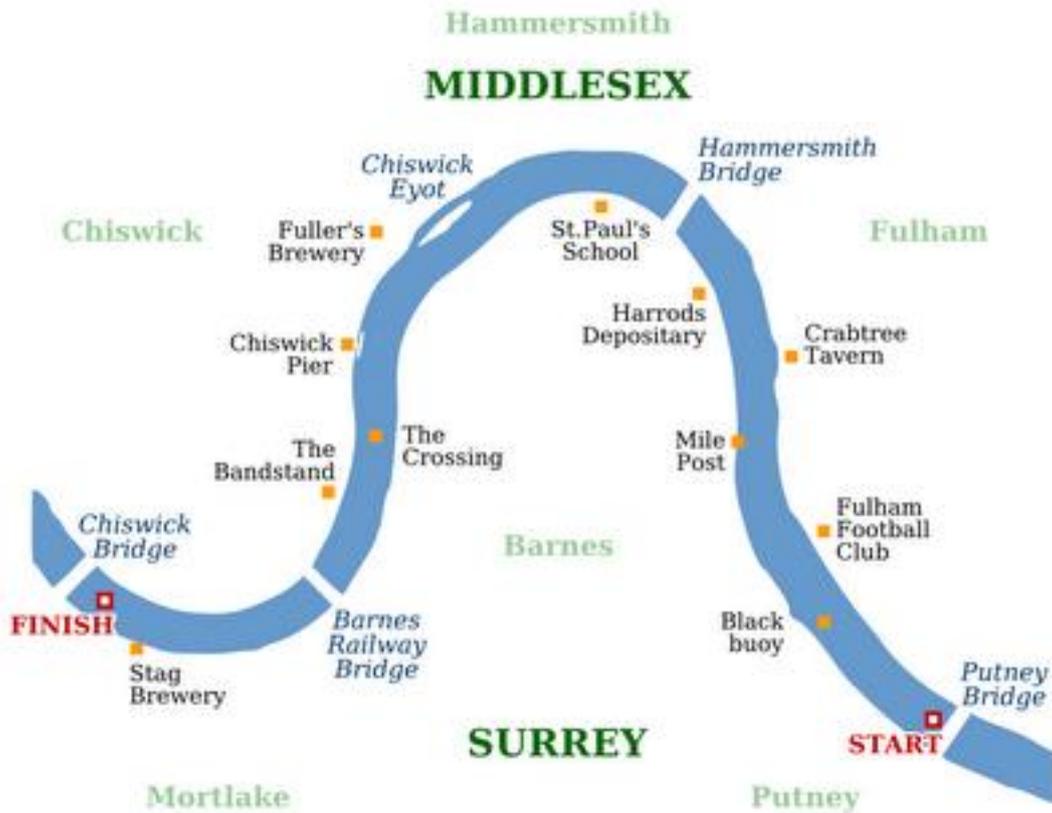
**ST PAUL'S SCHOOL
JUNIOR SCHOLARSHIP EXAMINATION**

PHYSICS

NAME _____

MAY 2014

SECTION A – PHYSICS



The Oxford-Cambridge boat race takes place each year on the River Thames in South-West London. St Paul’s sits approximately halfway along the course and is one of the famous landmarks along the route.

1. The boat race course is 6.8km long and the fastest ever time was recorded by Cambridge in 1998 with a time of 16 mins 19 sec.

- a. How long is the record time in seconds?

..... [1]

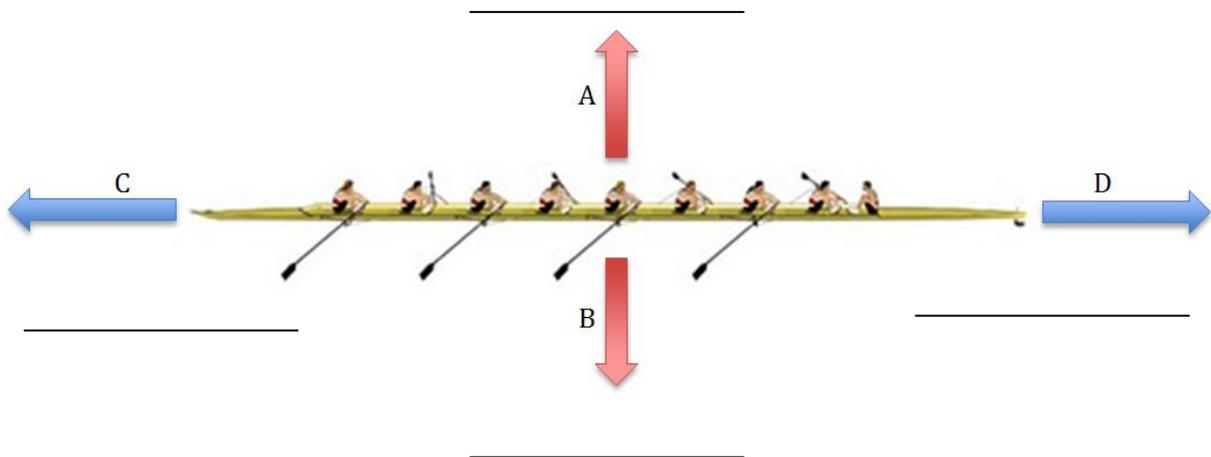
- b. Calculate the average speed of the fastest ever crew in m/s

.....

 [2]



2. The picture above shows the Cambridge crew practising their start. They start from stationary then accelerate quickly to the left. On the diagram below **name the four main vertical and horizontal forces** (labeled A, B, C & D) acting on boat very soon after the start:



[2]

- a. Circle the correct answers:

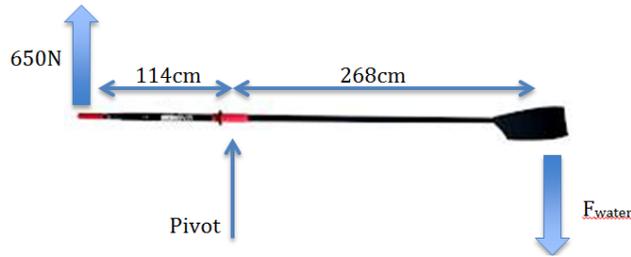
Force A is: *greater than / the same size as / less than* Force B

Force C is: *greater than / the same size as / less than* Force D

[2]

TURN OVER

3. The oarsmen apply a force to the water through their oars. Using the Principle of Moments and the diagram below, show that the force applied to the water (F_{water}) is approximately 280N. Show all of your working.



[2]

4. One of the Oxford rowers is struggling to understand the energy transfers taking place. He correctly recalls the equation:

$$\text{Energy Transferred [J]} = \text{Force [N]} \times \text{Distance travelled [m]}$$

He applies 650N over a distance of 1.1m (the length of his stroke) and calculates that he uses 715J to move the handle. Yet he says the oar only applies 280N over 1.1m to the water, hence more than 50% of the energy he uses is wasted.

Use the principle of conservation of energy to explain why he must be wrong and where he has made his mistake:

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.....

[2]

5. To apply the force to the oar, the rower uses both feet to push off against the footplate inside the boat. Given the ball of each foot has an area of 120cm^2 , calculate the pressure experienced by the balls of his feet.

Give your answer in N/cm^2 .

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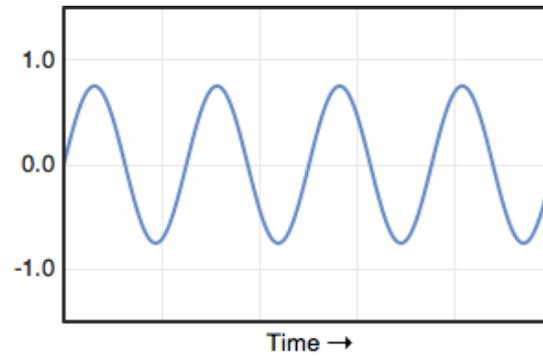
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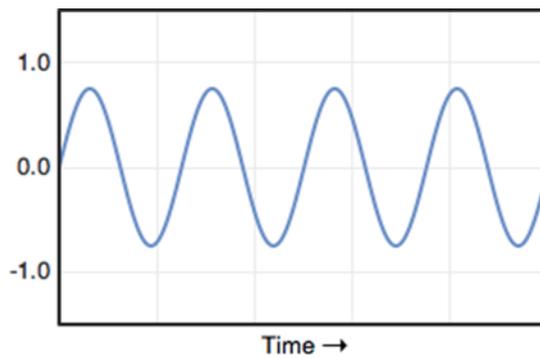
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[3]

6. When the first crew cross the finishing line, a gun is fired to signal the end of the race. The sound wave is displayed on the graph below using an oscilloscope.

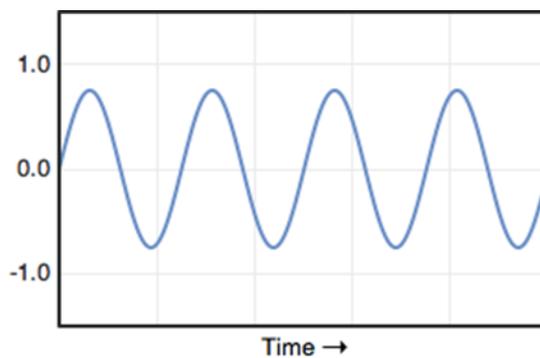


On the diagram below, draw the sound wave from a louder gun but with the same pitch.



[2]

On the diagram below, draw the sound wave from a higher pitched gun but with the same loudness.



[1]

TURN OVER

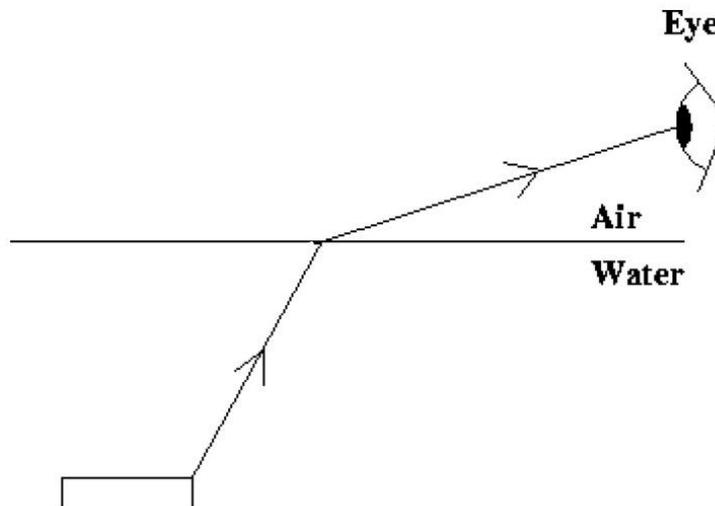
7. In keeping with tradition, the winning team throw their cox into the water at the end of the race, but they look to check the depth of the water first.



- a. Name the phenomenon responsible for the water appearing a different depth due to light rays changing direction as they exit the water.

..... [1]

- b. Carefully draw on the diagram below where the brick (located on the bottom of the river) appears to be.



[2]

- c. Hence, does the water appear deeper or shallower than it actually is?

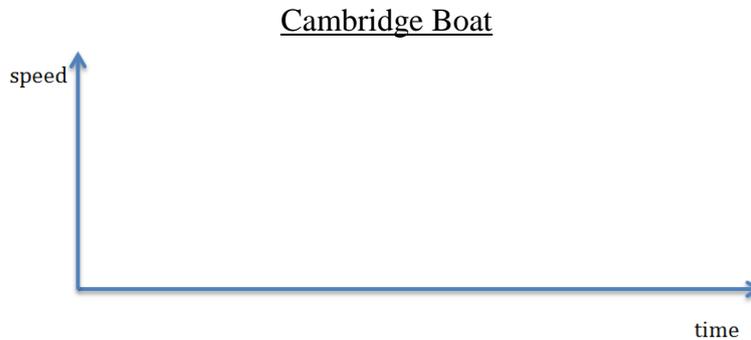
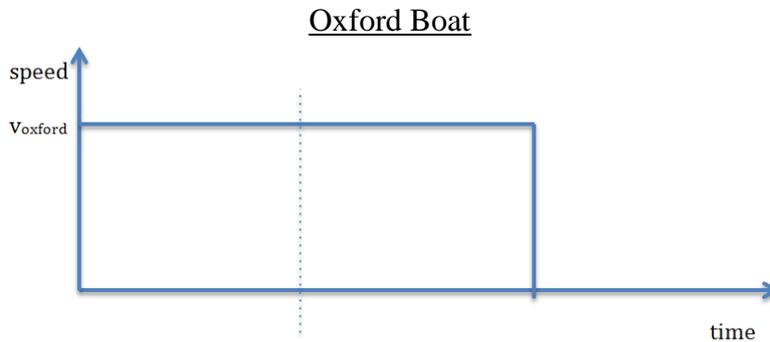
..... [1]

- 8. To save money, in 2014 the crews considered timing themselves over 6.8km in their hometowns, rather than travelling to London. Cambridge would have rowed on the (flowing) River Cam whilst Oxford would have been on the (stationary) Oxford Canal.

To overcome any advantage or disadvantage of the flowing current, the Oxford cox suggested that each boat row 3.4km in one direction then turn around and row 3.4km in the other direction; the total time for each crew would then determine the winner of the race.

On the axes labeled ‘Cambridge Boat’ below, draw a speed-time graph for the Cambridge boat marking with a dotted line where they turn around. Assume both of the following points:

- 1) the scale is the same as the Oxford Graph
- 2) the boats were evenly matched on still water



[2]

Given that the area under a speed-time graph represents the distance travelled, use the graphs above to explain whether the Cambridge crew should have accepted the challenge.

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[2]

END OF PHYSICS

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