Dulwich College

16+ Entrance Paper in Physics 2009-10

Name	Current School

- **The time allowed is 40 minutes**
- **You may use a calculator.**
- **No other material or paper is required.**
- **Answer all the questions in the space provided.**
- **Read all questions carefully, and show ALL your working.**

For examiner's use

Total Section A	/20
Total Section B	/10

Section A

Attempt all parts of the questions, and be careful to express your answers in clear English.

1. A car of mass 750kg is being driven by Fred at a constant speed of 20m/s. In order to maintain this constant speed, it is exerting a thrust force of 15kN.

a. Explain why a thrust force is required to maintain a constant speed.

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(2 marks)

b. Fred decides to overtake the car in front. He accelerates at a rate of 5m/s^2 for 3 seconds.

i. What is Fred's new speed after 3 seconds?

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(1 mark)

ii. Calculate the thrust force the car exerts during the acceleration, assuming all other factors remain constant. Show ALL your working.

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(3 marks)

c. Fred approaches a gentle bend in the road. Fred is able to maintain a constant speed as he rounds this bend, but his velocity changes. Explain how this is possible.

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(2 marks)

d. Around the corner Fred sees the traffic 100m in front of him is stationary. Other than his speed, state and explain two factors which will have an effect on Fred's *stopping distance*.

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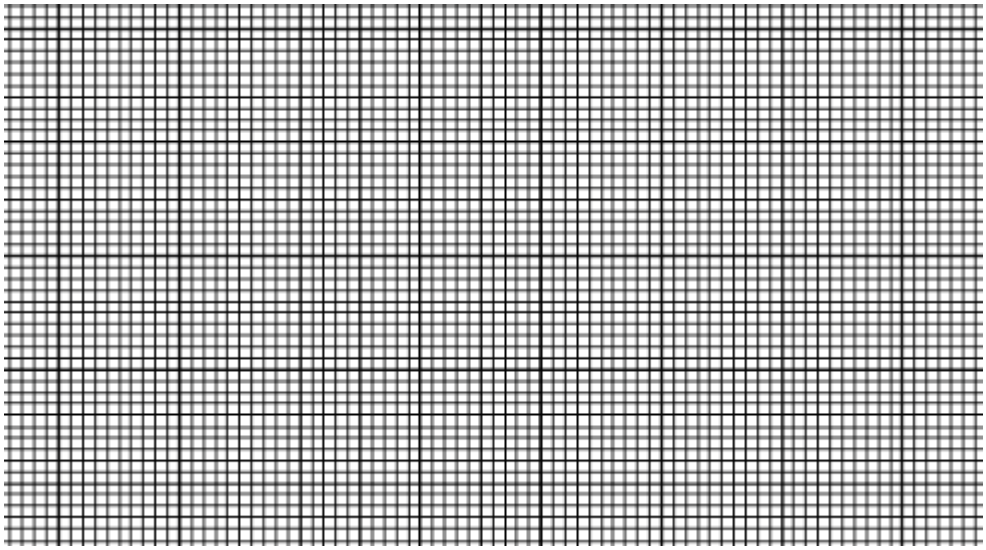
(4 marks)

e. Fred has a reaction time of 0.3s, after which he applies the brakes and decelerates steadily at a rate of $7m/s^2$. On the graph paper below, plot a velocity-time graph to illustrate the motion of the car from the moment Fred sees the stationary traffic to the moment the car stops. (3 marks)



f. Using only the graph you have plotted, prove that Fred will be able to stop safely, showing carefully how you used the graph to reach your answer.

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(2 marks)

g. As Fred sits in the queue, he turns off the engine. The metal the engine is made from contracts as the engine cools. Explain, in terms of the particles in the metal, why it contracts.

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(2 marks)

h. One reason the engine cools is because it emits *thermal radiation*. What is meant by *thermal radiation*?

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(1 mark)

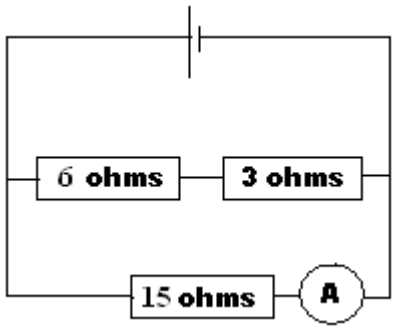
Section B

In each question below, **show your working** in the space provided, and then circle the correct answer.

1. Waves in the electromagnetic spectrum all travel at a speed 3.0×10^8 m/s in a vacuum. Red light has a wavelength of 700nm (1nm = 10^{-9} m). Calculate the frequency of red light.

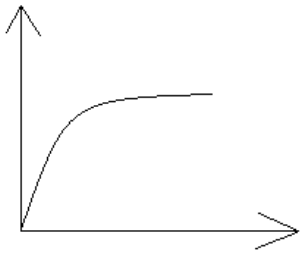
a. 4.3×10^{14} Hz b. 4.3×10^{13} Hz c. 2100 Hz d. 210Hz e. 2.3×10^{-15} Hz

2. In the circuit shown below, the ammeter reads 133mA. What is the potential difference across the ***6Ω resistor***?



a. 2V b. 1.3V c. 1V d. 0.6V e. 0.5V

3. A sketch graph is shown below. Which of the following relationships could it NOT represent?



a. The I-V characteristics of a bulb

b. A velocity-time graph showing acceleration

c. The relationship between pressure and volume for a gas at constant temperature

d. A distance-time graph showing deceleration

4. The half life of a radioactive substance is a constant for that substance. It is defined as the time it takes for the activity of a sample to fall by half. The half life of carbon-14, used in carbon dating, is 5730 years. An ancient bone is found to have an activity due to its Carbon-14 content which is approximately ¼ that of its modern day equivalent. Roughly how old is the bone?

a. 1433 years b. 5730 years c. 11460 years d. 17190 years

5. Stefan's Law states that the power output (in watts) from a star is directly proportional to its temperature (in kelvin) raised to the power four ie

$$P \propto T^4$$

A known star has a power output of $10x10^{27}$ and a temperature of 9000K. What power output would you expect a similar star of temperature 4500K to have?

a. $5x10^{27}$ W b. $2.5x10^{27}$ W c. $1.25x10^{27}$ W d. $6.25x10^{26}$ W

END OF TEST