GCE PHYSICS

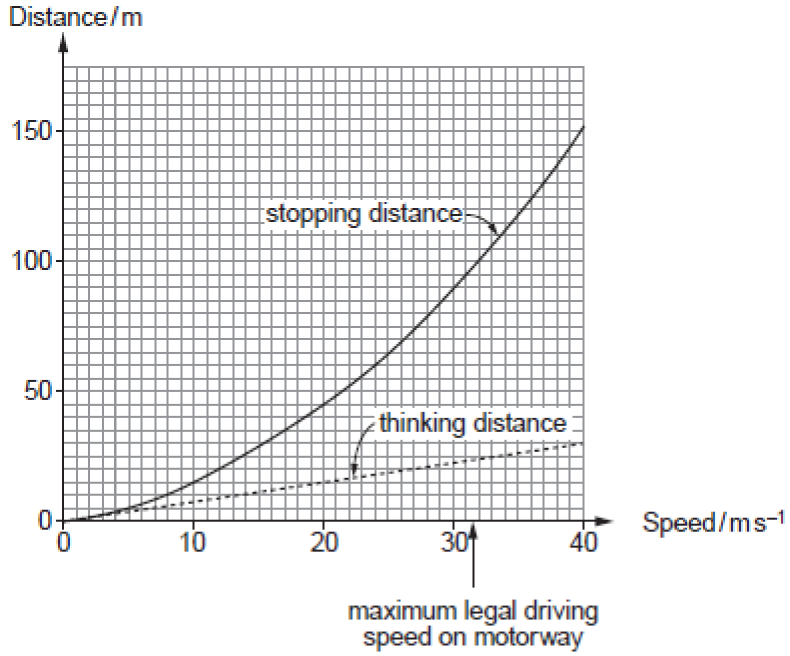
S21-A420QS

Assessment Resource number 7

Newtonian Physics Resource G

1. *(a)* The graphs show how a car driver's *stopping distance* and *thinking distance* are expected to depend on the speed at which the car is being driven (on a straight dry road).

thinking distance =	distance travelled between driver seeing a hazard ahead and starting to apply brakes
braking distance =	distance travelled while brakes are bringing car to rest (with constant deceleration)
stopping distance = thinking distance + braking distance	



(i) Determine the time interval that has been assumed between the driver seeing the hazard and starting to apply the brakes. [1]

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(ii) Determine the **braking** distance for a speed of 30 m s^{-1}. [1]

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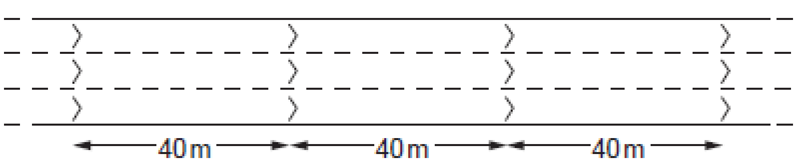
(iii) Evaluate whether or not a consistent value has been used for the car's deceleration while the brakes are being applied. [3]

(b) Marks, called 'chevrons', are painted at 40 m intervals on the road surface along a few stretches of motorway in the U.K.



Large notices say "Keep apart 2 chevrons". Using the information in part *(a)*, discuss whether the use of chevrons is likely to help prevent accidents on motorways. You may consider whether the scheme has disadvantages and whether it could be improved. [3]

2. *(a)* State what is meant by a body's *mean acceleration* over a period of time. [1]

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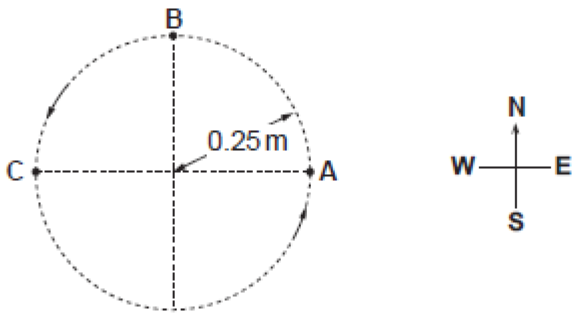
(b) Protons are 'stored' by being made to go round and round a circular path of radius 0.25 m at constant speed. They perform 5.2×10^6 revolutions per second.



(i) Show clearly that the protons' speed is approximately $8 \times 10^6\ \text{m s}^{-1}$. [2]

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(ii) Determine the magnitude and direction of a proton's acceleration at point B. [3]

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(iii) Calculate a proton's mean acceleration over the semicircle ABC. [3]

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(c) Two students discuss the mean force on a proton over one revolution ABCA. Adam says that the mean force is the same as the force at B, because the force is the same all the way round. Brian says that the mean force is zero. Evaluate these opinions. [2]

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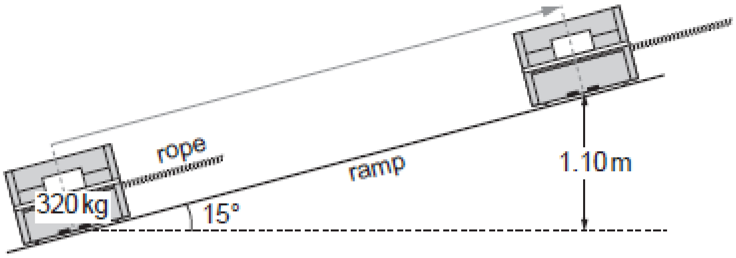
A piano of mass 320 kg is raised through a height of 1.10 m using a rope and a ramp angled at 15° to the horizontal. The process takes 35 s, during which the mean tension in the rope is 960 N.



(a) Show that the mean *power* used to pull the piano up the ramp is approximately 120 W. [3]

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(b) Calculate the *efficiency* of the rope and ramp as a means of raising the piano through a height of 1.10 m. [3]

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(c) Evaluate whether or not the kinetic energy given to the piano (at the beginning of the raising operation) is a major reason for inefficiency. [2]

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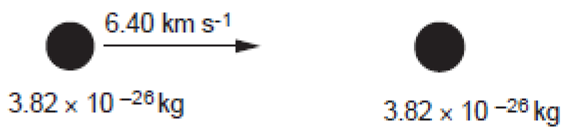
(a) (i) Show that the mean kinetic energy of (monatomic) gas molecules at a temperature of 1500 K is approximately 3×10^{-20} J. [2]

(ii) At 1500 K, sodium is a gas of monatomic molecules, each of mass 3.82×10^{-26} kg. Calculate their rms speed. [2]

(b) A sodium molecule moving at $6.40\,\mathrm{km\,s^{-1}}$ to the East collides with an almost stationary sodium molecule.



(i) Discuss whether a molecule with a speed of $6.40\,\mathrm{km\,s^{-1}}$ could be present at some instant in sodium gas at 1500 K and, if so, how it could have acquired this speed. [3]

(ii) After the collision one of the two molecules is moving to the East at $4.39\,\mathrm{km\,s^{-1}}$. Calculate the speed and direction of motion of the other molecule. [2]

(iii) Determine whether or not the collision is elastic. [3]

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(iv) Explain how Newton's 3rd law applies to the collision. [1]

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(v) Soon after the collision in *(b)*, one of the molecules gives out a photon of wavelength 589 nm. Evaluate whether or not the momentum of the photon significantly affects the molecule's velocity. [3]

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