


Physics

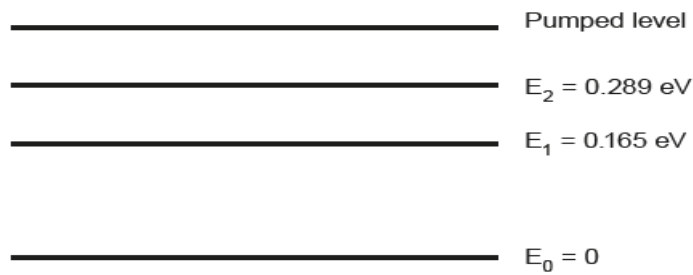
Question	Maximum Mark	Mark Awarded
#1	11	
#2	11	
#3	11	
#4	10	
#5	16	
Total	59	

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 **Question Bank**
Part of WJEC

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#1

When sunlight shines on the atmosphere of Mars, carbon dioxide molecules at a height of 75 km behave like the amplifying medium in a laser. The energy levels involved are shown in the following diagram. A population inversion occurs between energy levels E_1 and E_2 .



(a) (i) State what is meant by a population inversion. [1]

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(ii) Explain why a population inversion is needed for laser action. [2]

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(b) Calculate the output wavelength of this naturally occurring laser and determine the region of the electromagnetic spectrum in which it lies. [3]

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(c) The Llanesco crater is on the surface of Mars and has a cross-sectional area of 2290 km^2 . Carbon dioxide molecules in the Mars atmosphere collide with the surface and give rise to a surface pressure of 600 Pa . The mass of a carbon dioxide molecule is $7.3 \times 10^{-26} \text{ kg}$ and the perpendicular component of the speed of the molecules to the surface is 550 m s^{-1} **before** and **after** they collide with the surface. Calculate the number of carbon dioxide molecules that collide with the Llanesco crater in 1 s. [5]

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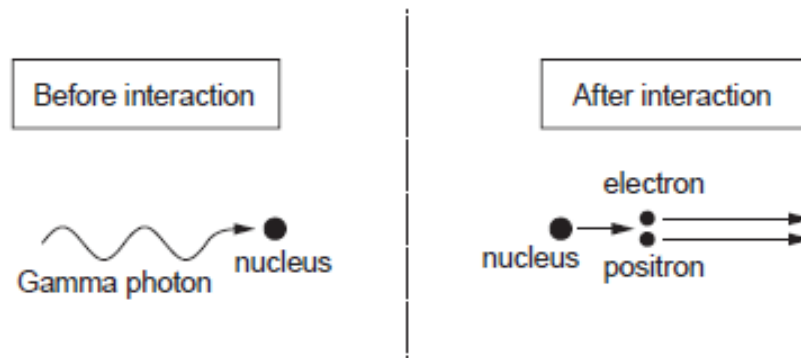
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Question taken from Eduqas examination paper 842002, June 2017

#2

5. The following interaction can take place when a gamma photon encounters a stationary nucleus.



The energy of the gamma photon “creates” a positron-electron pair and the nucleus gains some momentum in the direction of the original gamma photon.

- (a) Show that this interaction can only take place if the energy of the gamma photon is greater than 1.02 MeV. [3]

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- (b) The actual energy of the incident gamma photon is 1.03 MeV. Assuming that the kinetic energy of the nucleus after the interaction is negligible, explain briefly why the kinetic energies of the positron and electron are approximately 0.005 MeV each. [2]

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- (c) Use the kinetic energies of 0.005MeV and conservation of momentum to show that the speeds of the positron and electron are $4.2 \times 10^7\text{ms}^{-1}$ and that the momentum of the nucleus after the collision is $4.7 \times 10^{-22}\text{kgms}^{-1}$. [4]

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- (d) The momentum of the nucleus ($4.7 \times 10^{-22}\text{kgms}^{-1}$) is essential otherwise conservation of momentum would be impossible. Deduce whether or not the assumption in part (b) is valid (the mass of the nucleus is $3.3 \times 10^{-25}\text{kg}$). [2]

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Question taken from Eduqas examination paper 842103, June 2019

#3

2. A wooden block on a string (ballistic pendulum) is a device that can be found at well equipped shooting ranges. It is used to find the speed of a bullet. To calculate the speed it is necessary to use both the principles of conservation of energy and momentum.

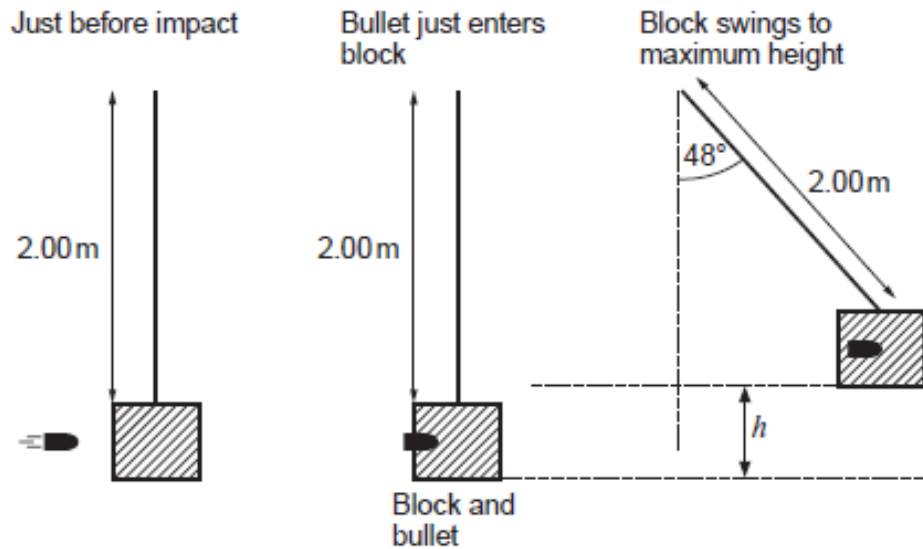
(a) State the principle of conservation of energy. [1]

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(b) When a bullet of mass 10.0g is fired horizontally into a pendulum of mass 1.90 kg, the block rises through an angle of 48° as shown. The pendulum string is 2.00 metres long.



(i) Show that the height, h , the block rises is approximately 0.70 m. [2]

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(ii) Using the principle of conservation of energy, determine the velocity of the block and the bullet just after the bullet has embedded itself in the block. [2]

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(c) (i) State the principle of conservation of momentum. [2]

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(ii) Determine the speed of the bullet just before it enters the block. [2]

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(d) Discuss whether you feel it would be appropriate for a Physics teacher to carry out this experiment in school with a group of sixth form students. [2]

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Question taken from Eduqas examination paper 842001, June 2019

#4

3. (a) State the principle of conservation of momentum. [2]

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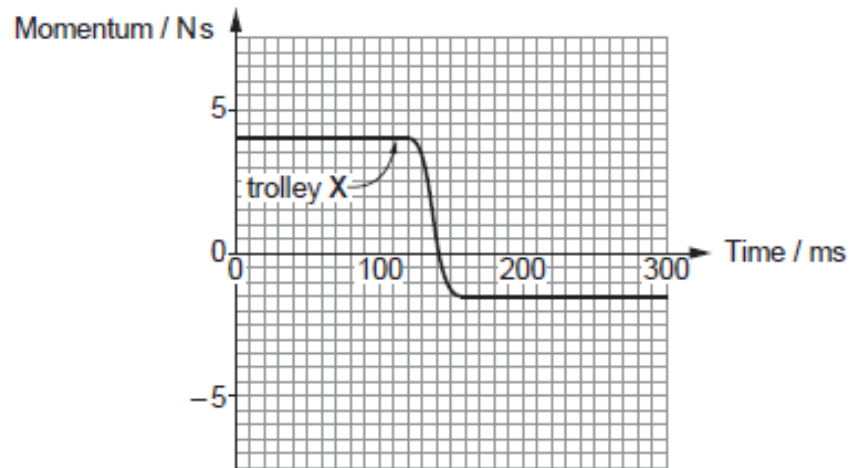
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- (b) A trolley, X, travels towards a stationary trolley, Y. See diagram.



The trolleys collide head-on. A momentum-time graph is given for trolley X.



- (i) Trolley Y has a mass of 2.4 kg. Determine its velocity after the collision. [3]

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- (ii) Using the same graph grid (opposite) carefully sketch a graph of Y's momentum between 0 and 300ms. [3]
- (iii) Use the momentum-time graph for X to estimate the mean *force* on X during the collision. [2]

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Question taken from Eduqas examination paper 842101, June 2019

#5

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

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

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



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

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

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- (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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Question taken from Eduqas examination paper 842101, November 2020