

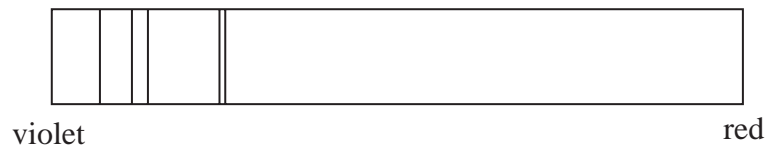
- 1 Analysing the light from a star allows elements present in its outer atmosphere to be identified because each element produces a distinctive set of spectral lines.
- *(a) Describe how a spectral line is produced by a hot gas, explaining why a particular element can only give rise to particular frequencies.

(6)

- (b) The diagram shows the spectral lines produced by a particular element when observed in a laboratory.



The diagram below shows the spectral lines obtained by analysing the light from a star. This shows the same pattern of lines, but in a different part of the spectrum.



Name this effect and explain what may be deduced about the motion of this star relative to the Earth.

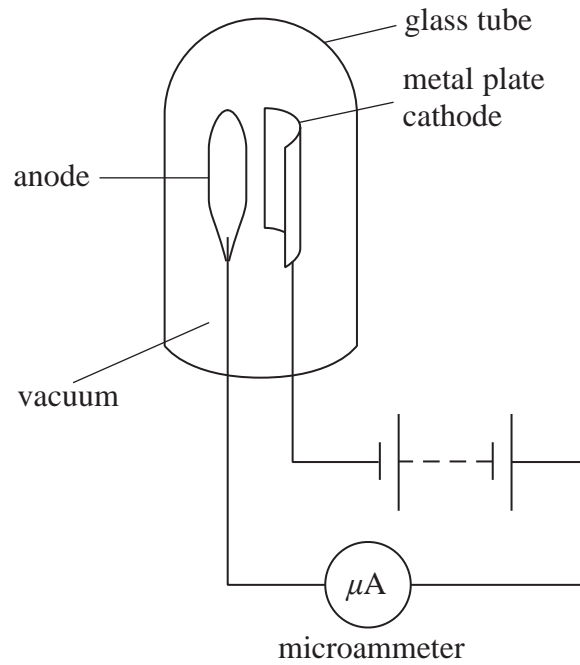
(3)

- (c) Suggest what the phenomena in parts (a) and (b) imply about the nature of light.

(1)

(Total for Question = 10 marks)

2 Phototubes are devices which make use of the photoelectric effect to detect light above a specific frequency.



(a) Explain why

- no current flows when the phototube is in darkness
- current flows in the circuit when the phototube is illuminated by light above a specific frequency.

(5)

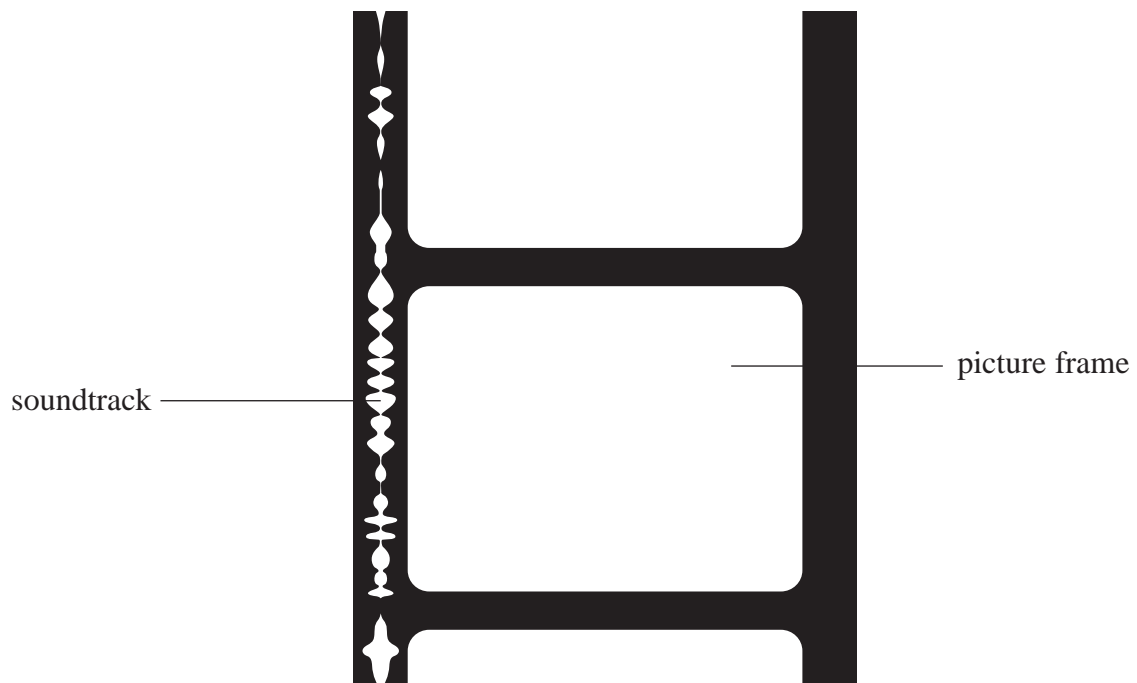
- (b) Make an appropriate calculation to explain why caesium is used as the cathode for visible light but zinc is not.

work function of zinc = 3.63 eV

work function of caesium = 2.14 eV

(4)

- (c) Before digital technology was used, the films used at the cinema had an optical soundtrack next to the picture frames.



The film, including the soundtrack as shown, moves through a projector past a source of light. Light is detected by a phototube on the other side of the soundtrack. The changing current produced by the phototube circuit is converted to a sound signal with the same variation in amplitude and frequency as the original sound.

(i) State what is meant by amplitude.

(1)

(ii) Explain how the changing pattern of the soundtrack produces a changing current in the phototube circuit.

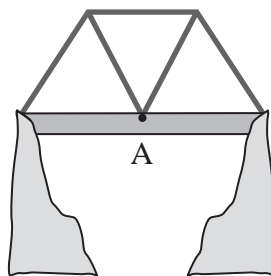
(3)

(Total for Question = 13 marks)

- 3 To increase the load that a bridge can withstand, some bridges have beams in a triangular design. These beams are called trusses.



A simple truss bridge is shown.



- (a) A lorry stops at point A.

Draw a free-body force diagram for the forces acting on the bridge at point A.

(3)



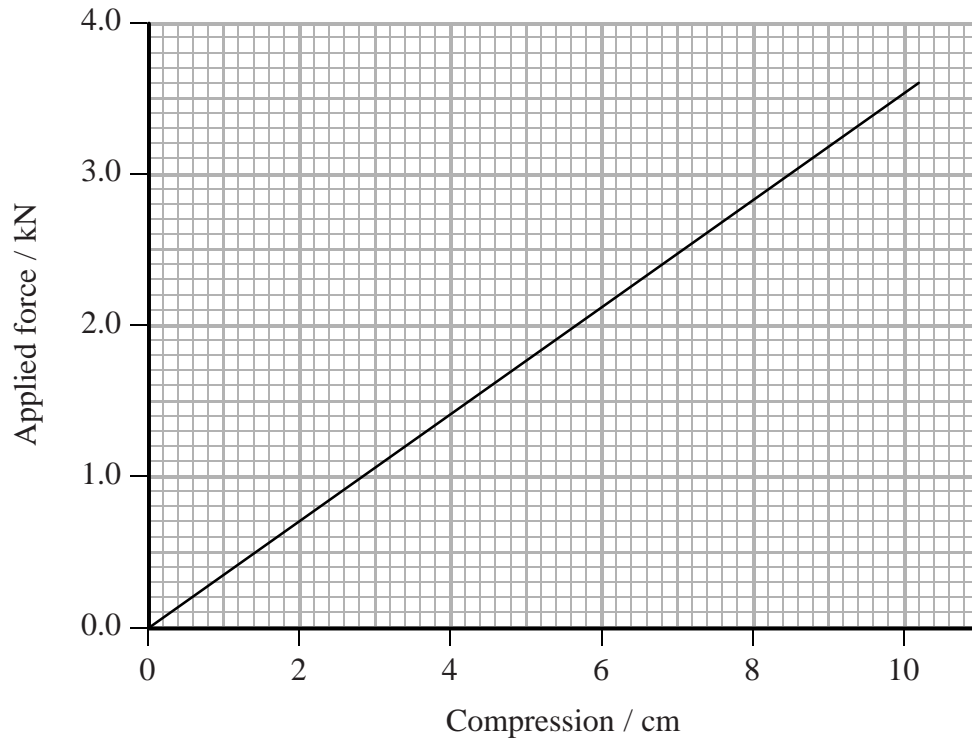
- (b) Explain why the structure of the bridge allows it to withstand greater loads.

(2)

(Total for Question = 5 marks)

4 A pogo stick is a toy used for jumping up and down. The pogo stick contains a spring which is under compression.

(a) The force-compression graph for the spring from the pogo stick is shown.

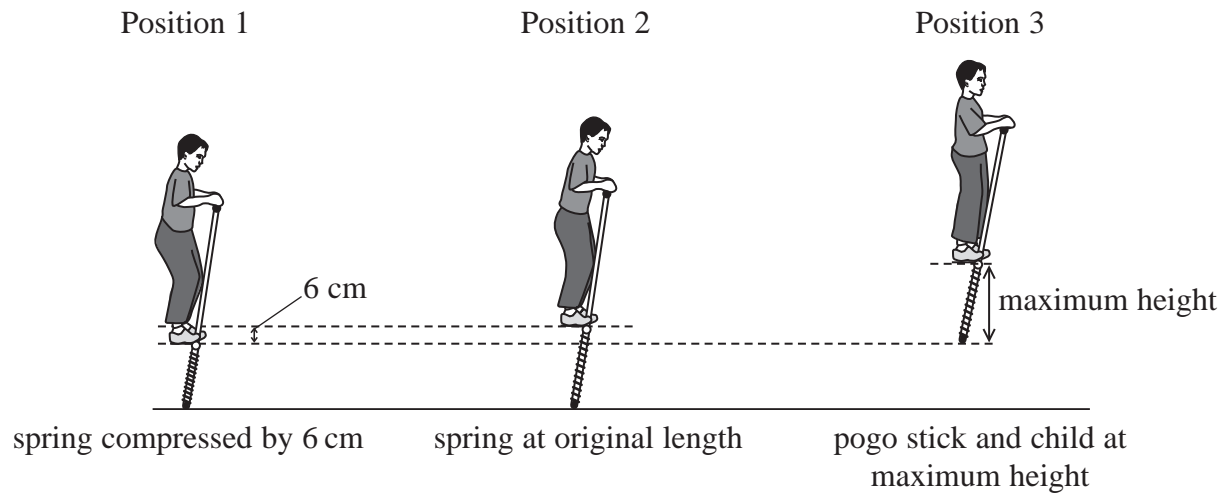


Determine the spring constant for the spring.

(2)

Spring constant =

- (b) Inside the pogo stick the spring is compressed by 3 cm. A child jumps onto the foot rest of the pogo stick and the spring is compressed by a further 6 cm. The pogo stick and child move up to a maximum height at position 3.



- (i) Use the graph to show that the work done by the child on the spring is about 130 J.

(3)

- (ii) When the spring is at its original length, as shown in position 2, the child is at his maximum speed.

State the energy transfers that occur as the child moves upwards from position 1 to position 2.

(2)

- (iii) By considering the energy transfers as the child moves upwards from position 1 to position 2, calculate the maximum speed of the child.

mass of child and pogo stick = 35 kg.

(4)

Maximum speed =

*(c) Between positions 1 and 2 the pogo stick is pushing down on the ground.

With reference to Newton's laws of motion, explain how this downward force causes the child and pogo stick to rise.

(3)

(Total for Question = 14 marks)