

Exam Practise 6 Short Answer

Q

Q1

A ball of mass 0.20 kg falls vertically and hits the ground at a velocity of 4.2 m s^{-1} . It rebounds vertically at an initial speed of 3.4 m s^{-1} .

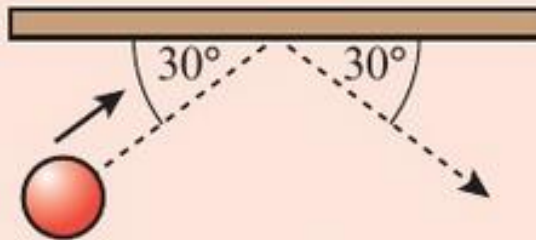
(a) Calculate the change of momentum of the ball. **(3 marks)**

(b) What is the impulse applied to the ball by the ground? **(1 mark)**

(c) The average force exerted on the ball while it was in contact with the ground was 18.0 N . Calculate the contact time. **(2 marks)**

Q2

A football of mass m is kicked against a wall. It approaches the wall at speed v and rebounds at the same speed as shown below.

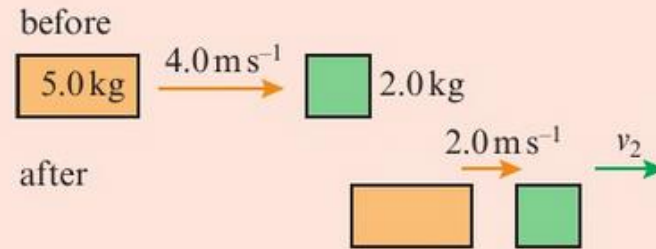


Use the law of conservation of momentum to explain why the ball rebounds at the same angle.

(3 marks)

Q3

The diagrams show two objects before and after a collision.

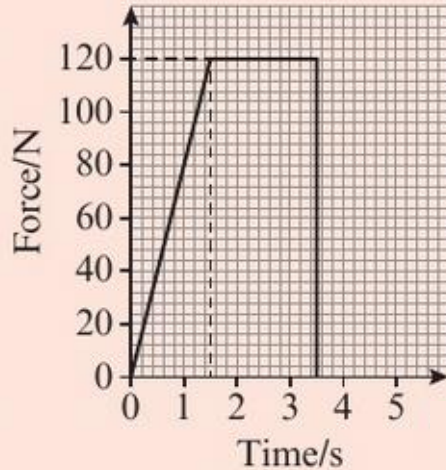


- (a) Calculate the final velocity of the 2.0 kg mass. **(2 marks)**

- (b) Determine whether or not this collision is elastic. **(3 marks)**

Q4

A man pushes a child on a sledge along horizontal snow with a force that varies in the way shown in the figure. The sledge is initially at rest. The man stops pushing after 3.5 s and lets it slide away. The frictional drag from the snow is negligible. The total mass of the sledge and child is 75 kg.



- (a) State the physical quantity represented by the area under the graph and give its correct SI unit. **(1 mark)**
- (b) Calculate the velocity of the sledge at the moment the man stops pushing. **(4 marks)**

- (c) Later, when the same child and sledge is sliding over horizontal snow at 4.0 m s^{-1} , a second child of mass 45 kg runs in the same direction at 6.0 m s^{-1} and jumps onto the moving sledge.
- (i) Calculate the velocity of the sledge with two children just after the second child lands on it. **(2 marks)**
- (ii) State whether this is an elastic or inelastic collision and justify your answer by calculation. **(3 marks)**

Q5

- 1 An electron and a proton are both accelerated through a potential difference of 2000 V.
 - (a) Calculate the energy gained in each case and express your answer in both electronvolts and joules. **(3 marks)**

Q6

A kettle contains 0.80 kg of water at 25°C. Calculate the minimum amount of energy needed to:

(a) Raise the temperature of the water to 100°C. **(2 marks)**

(b) Change the state of all of the water from a liquid to a gas at 100°C. **(2 marks)**

Q7

- 1 Convert the following temperatures to the Kelvin scale:
 - (a) a room temperature of about 21°C (1 mark)
 - (b) the boiling point of water at 100°C . (1 mark)

- 2 Convert the following temperatures to the Celsius scale:
 - (a) the temperature of empty space,
 2.7 K (1 mark)
 - (b) The temperature at the surface of the Sun,
 5800 K . (1 mark)

Q8

Iron-56 has 26 protons and $(56 - 26) = 30$ neutrons in the nucleus. Use the data below to calculate the nuclear binding energy of the iron-56 nucleus and give your answer in J and MeV.

- atomic mass of iron-56 = 55.934939 u
 - mass of an electron $m_e = 0.000549$ u
 - mass of a proton $m_p = 1.007276$ u
 - mass of a neutron $m_n = 1.008665$ u
- (5 marks)**

Q9

Estimate the total energy that could be released from 1 kg of uranium-235 by the nuclear fission reaction yielding ${}_{36}^{90}\text{Kr}$ and ${}_{56}^{144}\text{Ba}$. Assume that 1 kg ${}^{235}\text{U}$ contains 2.56×10^{24} atoms. **(4 marks)**

$$m_{\text{U}} = 235.043930 \text{ u}$$

$$m_{\text{Kr}} = 89.919517 \text{ u}$$

$$m_{\text{Ba}} = 143.922953 \text{ u}$$

$$m_{\text{n}} = 1.008665 \text{ u}$$

$$\text{u} = 1.66 \times 10^{-27} \text{ kg}$$

Q10

Use the data below to calculate the energy released by the nuclear fusion of deuterium, hydrogen-2, with tritium, hydrogen-3. **(4 marks)**

$$m_n = 1.008665 \text{ u}$$

$$\text{atomic mass of deuterium} = 2.014102 \text{ u}$$

$$\text{atomic mass of tritium} = 3.016050 \text{ u}$$

$$\text{atomic mass of He-4} = 4.002602 \text{ u}$$

Q11

Copy and complete the transformation equations below:



Q12

Radon gas has a half-life of about 1 minute.

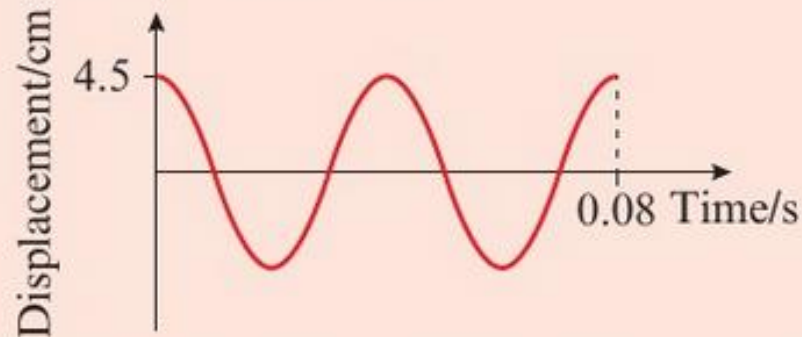
A sample of radon gas is placed into a sealed container and a detector in the container records an activity of 160 counts per second, after allowing for background radiation.

(a) State what fraction of the original isotope remains after: (i) 1 minute, (ii) 2 minutes, (iii) 5 minutes. **(3 marks)**

(b) Predict the activity after 10 minutes. **(2 marks)**

Q13

The graph below shows displacement versus time for a simple harmonic oscillator:



- (a) What is the amplitude and the frequency of this oscillator? **(3 marks)**

$$\begin{aligned} \text{Amplitude} &= 4.5 \text{ cm. Time period} = \frac{0.080}{2} \\ &= 0.040 \text{ s, so } f = \frac{1}{T} = \frac{1}{0.040} = 25 \text{ Hz} \end{aligned}$$

- (b) At what times does the oscillator have maximum positive velocity? **(2 marks)**

Maximum positive velocity corresponds to maximum positive gradient, so the times are 0.030 s and 0.070 s.