Name of the Student:_____

Max. Marks : 26 Marks   **Time : 26 Minutes**

Q1.
(a) Explain what is meant by the principle of conservation of momentum.

(2)

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(b) The picture shows a toy car initially at rest with a piece of modelling clay attached to it.

A student carries out an experiment to find the speed of a pellet fired from an air rifle. The pellet is fired horizontally into the modelling clay. The pellet remains in the modelling clay as the car moves forward. The motion of the car is filmed for analysis.

The car travels a distance of 69 cm before coming to rest after a time of 1.3 s.

(i) Show that the speed of the car immediately after being struck by the pellet was about 1 m s^{-1}.

(2)

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(ii) State an assumption you made in order to apply the equation you used.

(1)

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(iii) Show that the speed of the pellet just before it collides with the car is about 120 m s^{-1}

mass of car and modelling clay = 97.31g

mass of pellet = 0.84 g

(3)

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(c) The modelling clay is removed and is replaced by a metal plate of the same mass. The metal plate is fixed to the back of the car. The experiment is repeated but this time the pellet bounces backwards.

*(i) Explain why the speed of the toy car will now be greater than in the original experiment.

(3)

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(ii) The film of this experiment shows that the pellet bounces back at an angle of 72° to the horizontal.

Explain why the car would move even faster if the pellet bounced directly backwards at the same speed.
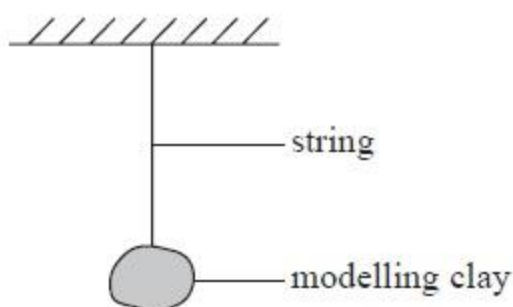
(1)

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(d) The student tests the result of the first experiment by firing a pellet into a pendulum with a bob made of modelling clay. She calculates the energy transferred.

The student's data and calculations are shown:

Data

mass of pellet = 0.84 g

mass of pendulum and pellet = 71.6 g

change in vertical height of pendulum = 22.6 cm

Calculations

change in gravitational potential energy of pendulum and pellet
   = 71.6 × 10^{-3} kg × 9.81 N kg^{-1} × 0.226 m = 0.16 J

therefore kinetic energy of pendulum and pellet immediately after collision = 0.16 J

therefore kinetic energy of pellet immediately before collision = 0.16 J

therefore speed of pellet before collision = 19.5 m s^{-1}

There are no mathematical errors but her answer for the speed is too small.

State and explain which of the statements in the calculations are correct and which are not.

(4)

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(Total for Question = 16 marks)

Q2.

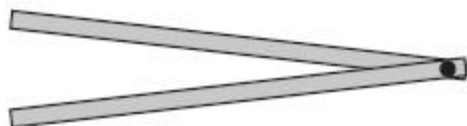The diagram shows a battery-powered clock on a wall. It has a minute hand and an hour hand.

(a) Calculate the average angular velocity of the minute hand.

(2)

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Angular velocity = ...

(b) The diagram shows the position of the minute hand when the time is 1 : 44 and when the time is 1 : 46.

The diagram is not to scale.

Show that the work done against the force of gravity to move the minute hand from 1 : 44 to 1 : 46 is about 1 mJ.

mass of minute hand = 14 g
length of minute hand = 8.0 cm

(5)

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(c) The clock uses a 1.5 V cell and draws a maximum current of 8.0 µA.

After a time, the maximum power of the cell has reduced to 65% of its initial value making the clock run slowly.

Calculate the time taken for the minute hand to move from the 1 : 44 position to the 1 : 46 position.

(3)

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Time taken = ...

(Total for question = 10 marks)