華僑中學
HWA CHONG INSTITUTION

2026 Term 3 Physics Class Test 2	Duration: 55 min
Topics: Kinematics, Mass & Weight, Dynamics, Energy, Work & Power	Level: Sec 3 (IP) **Set B**

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Class / Index No: 301 30

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your name, date, class and index number in the spaces at the top of this page.
Shade your student ID in the grid at the top right corner of this page.

Answer **ALL** questions in the paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
You may use an approved calculator.

Each correct answer scores one mark. No marks are deducted for wrong answers.
Show clear working for calculations and include appropriate units.

FOR EXAMINER'S USE		
Qn	Awarded	Maximum
SECTION A		
1-5	4	5
SECTION B		
6	2	4
7	4	6
8	0	5
9	3	6
10	3	9

0 / 0

0 / 0

0 / 0

FOR EXAMINER'S USE
Total: 16 / 35

This paper consists of 10 printed pages including this cover page.

Section A: MCQ (5 marks)

Answer **all** questions. **Shade** your answer for each question in the circle next to the option.

1 A stone is thrown vertically upwards.

Which row correctly describes the velocity and acceleration of the stone while it is moving upwards?

1 / 1

	acceleration of the stone	velocity of the stone
● A	constant	decreasing
○ B	decreasing	constant
○ C	constant	constant
○ D	decreasing	decreasing

A

2 Which row correctly states the definition of weight and the instrument used to measure it?

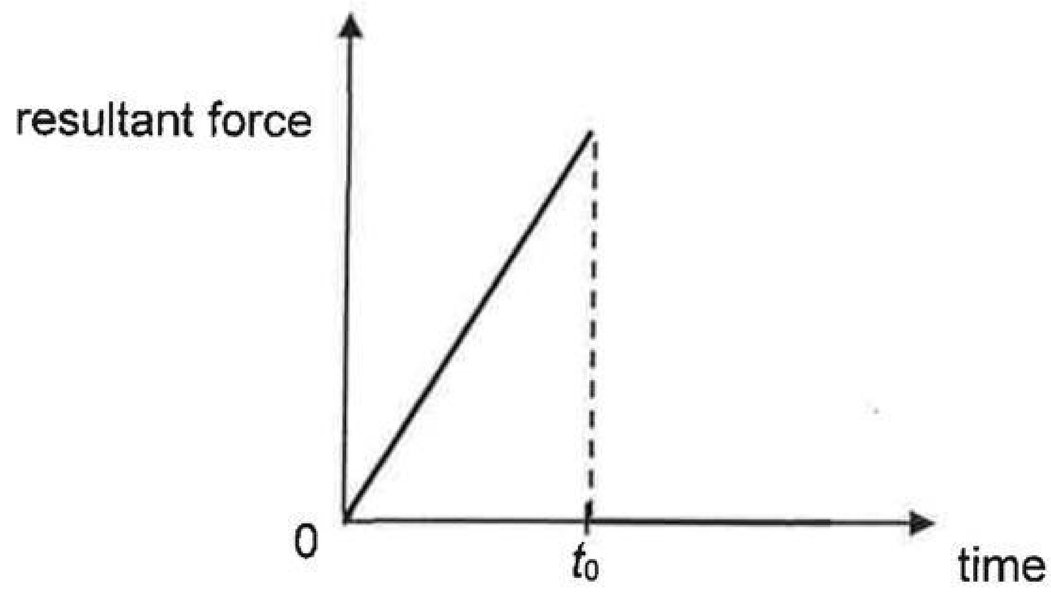
0 / 1

	definition of weight	measuring instrument
○ A	amount of matter in an object	electronic balance
○ B	amount of matter in an object	spring balance
● C	gravitational force acting on an object	electronic balance
○ D	gravitational force acting on an object	spring balance

C

3 A resultant force acts on an object and causes it to move in a straight line.

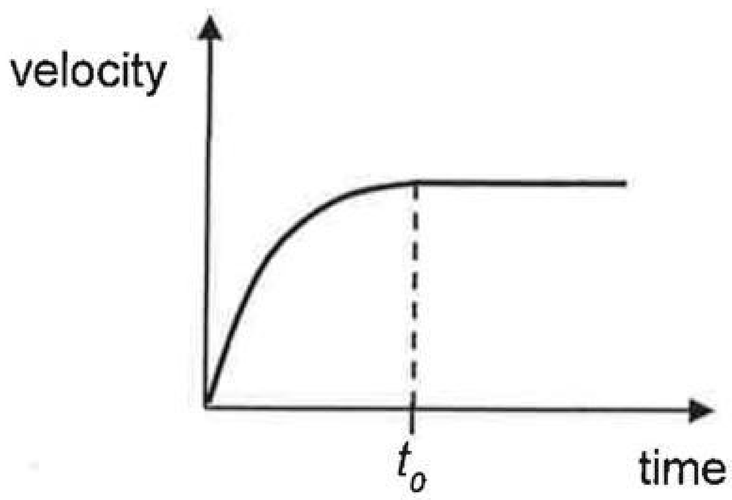
The graph shows how the resultant force varies with time.



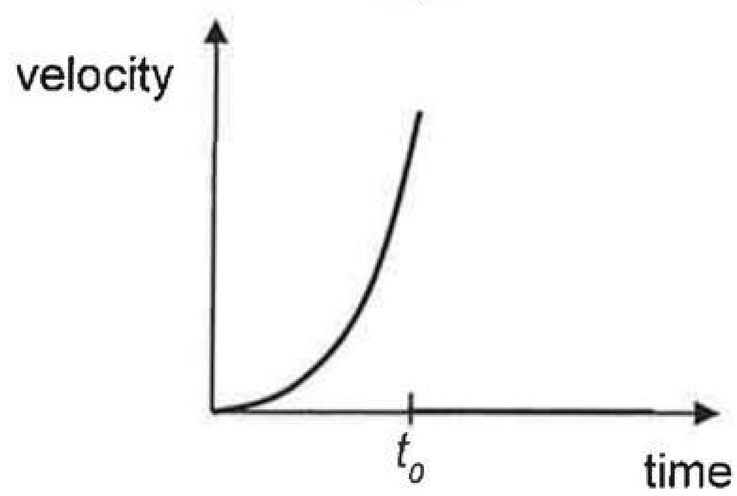
Which graph is the velocity-time graph for the object?

B

O A

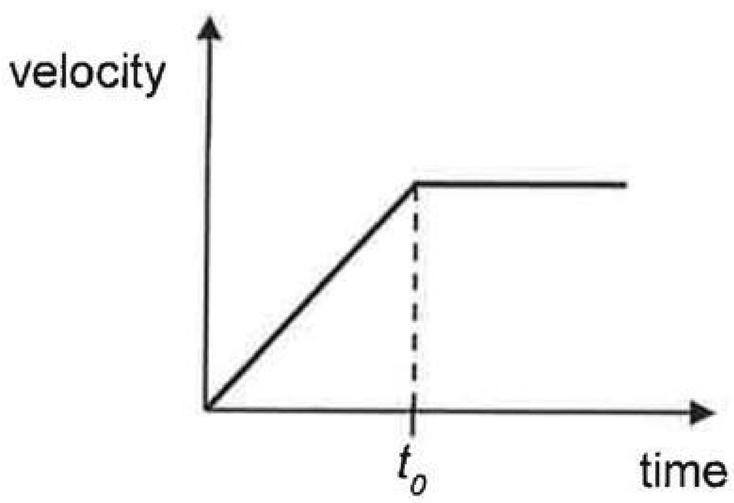


B

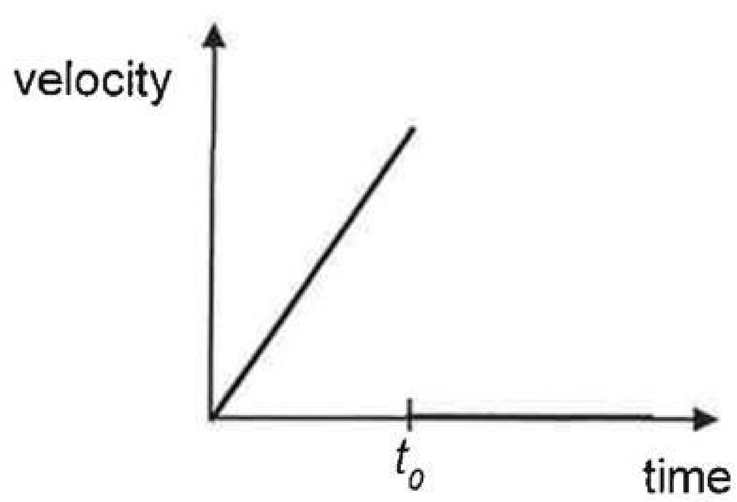


1 / 1

O C



O D



4 A machine has an efficiency of 25%. It produces 200 J of useful energy.

What is the total energy input?

- O A 45 J
- O B 150 J
- O C 500 J
- ● D 800 J

1 / 1

D

5 Country Z is a landlocked, mountainous country with a massive agricultural sector that relies heavily on natural river valley systems for crop irrigation. The country is seeking to diversify its energy grid away from fossil fuels.

Which renewable energy source is least suitable if the country wishes to minimise disruption to river flow, agricultural irrigation and valley ecosystems?

- O A Large-scale solar farms installed in the uncultivable high-altitude desert plateaus
- O B Wind farms comprising turbine arrays situated along windy tall mountain ridges
- ● C Conventional hydroelectric dams built across major rivers
- O D Geothermal power plants built near volcanic geological fault lines

1 / 1

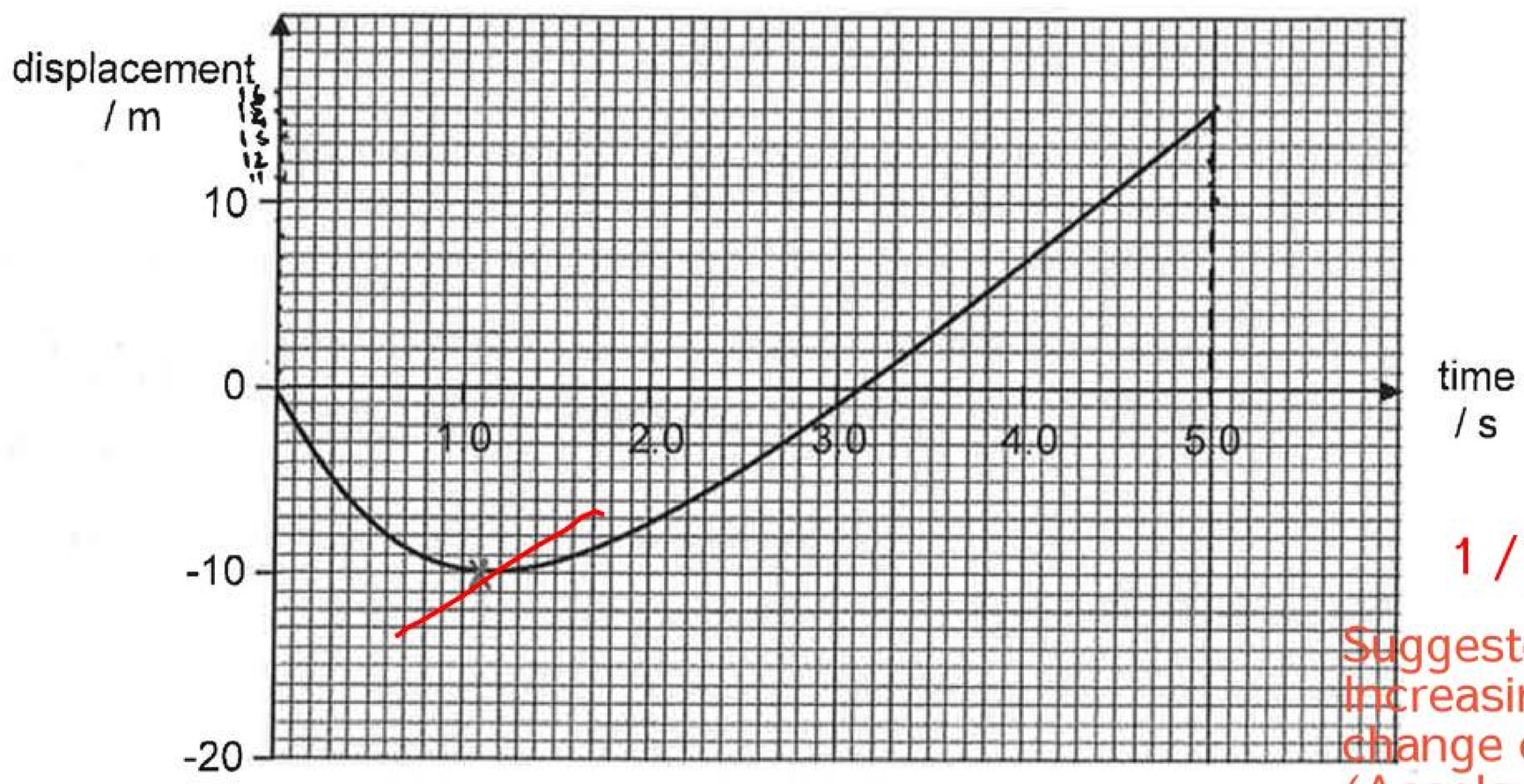
C

Section B: Structured Question (30 Marks)

Answer all the questions in the spaces provided.

6 A drone flew downwards from a building and flew back up after some time.

Fig. 6.1 shows the displacement-time graph of the drone's motion.



1 / 1

Suggested Answer : Increasing rate of change of velocity. (Acceleration meant rate of change in velocity, not always rate of increase in velocity, can also be rate of decrease in velocity.)

Fig. 6.1

(a) State what is meant by increasing acceleration.

It means that the velocity is increasing rapidly in a ~~she~~ shape. [1]

0 / 1

Incomplete/incorrect description (-1)

(b) State the distance the drone flew upwards.

height = 25m [1]

1 / 1

(c) From Fig. 6.1, explain how you can tell the drone is accelerating during the first part of its motion.

The displacement-time graph is in a non-linear shape. If there is no acceleration velocity is constant and the displacement each ~~sec~~ second is constant. [1]

0 / 1

Incorrect/incomplete explanation (-1)

(d) On Fig. 6.1, mark with an **X**, the point where the instantaneous velocity of the ball is 0 m/s. [1]

Suggested Answer : The gradient of the graph represents velocity, and it is constantly changing / Rate of change of displacement is not constant

5

7 A 1.2 kg coconut drops from a very tall tree and falls through air.

The air resistance F_a acting on the coconut is related to the falling velocity v as shown:

$$F_a = kv^2, \text{ where } k = 0.30 \text{ kg m}^{-1}$$

Assume Earth's gravitational field strength is 10 N kg^{-1}.

Suggested answer
As the coconut falls, it accelerates. Since velocity increases, air resistance on the coconut will increase. [1]

(a) Explain, using ideas about forces, how the acceleration of the coconut changes as it falls till it reaches terminal velocity.

The acceleration of the coconut will ~~first increase~~ be at 10N kg^{-1} as it first drops down ~~a~~ so the acceleration is constant. As the ~~air~~ air resistance gradually gets higher the acceleration decreases and will become 0 as the air resistance and gravitational force balances out. [3]

No mention of relation of velocity and air resistance (-1)

2 / 3

The resultant force will decrease, and this decreases the downward acceleration. [1]

When the air resistance balances the weight of the coconut, resultant force is 0 N and there will be no acceleration. [1]

(b) Calculate the terminal velocity of the coconut.

~~F = 0.30x~~ $ma = mg - f$

$0 = 12N - f$

$12N = 0.3kgm^{-1} \times v^2$

$40 = v^2$

~~$12 = 0.3 \times v^2$~~

~~$40 = v^2$~~

$v = \sqrt{40}$

$= 6.32 \text{ ms}^{-1}$

$= 6.3 \text{ ms}^{-1}$ (2 s.f)

terminal velocity = 6.3 ms^{-1} [2]

2 / 2

(c) Fig. 7.1 shows the velocity-time graph of the coconut's motion before it enters the water at t_1.

At time t_1, the coconut strikes a body of water in a lake. It continues descending till it reaches a constant velocity, before landing at the bottom of the lake at time t_2.

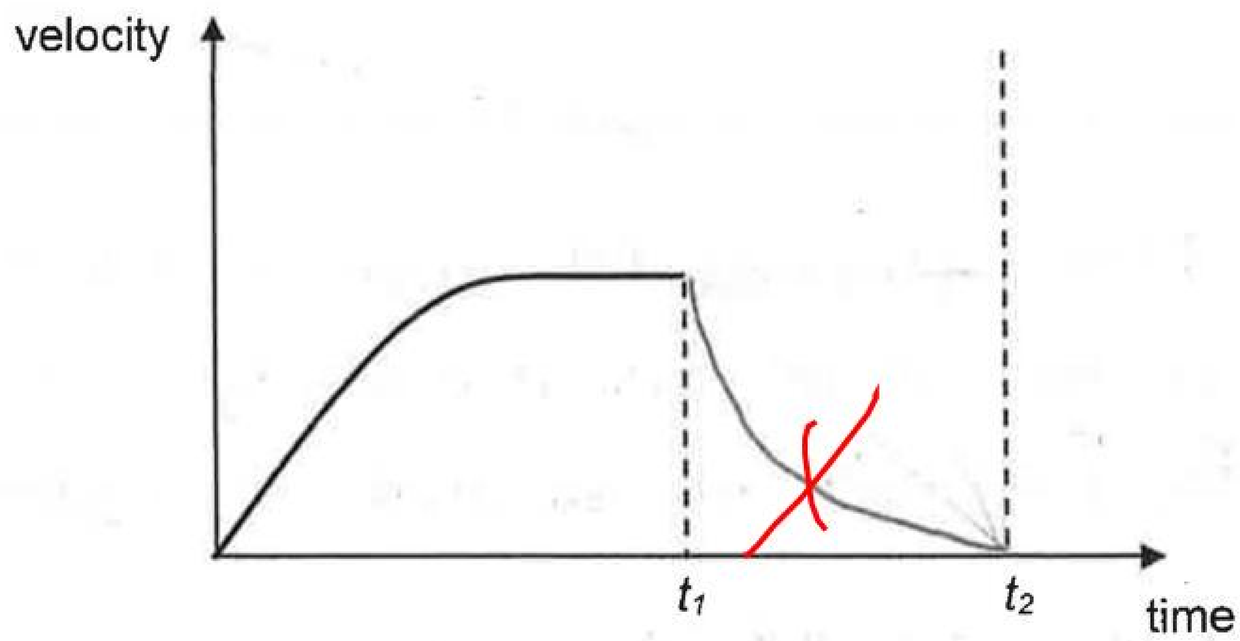


Fig. 7.1

Sketch the velocity-time graph for the descent of the coconut in the lake. [1]

0 / 1

Wrong shape for graph (-1)

8 A rocket experiences a constant deceleration upon entering Earth's gravitational field.

Table 8.1 shows some information about the rocket's entry.

Table 8.1

altitude from sea level	830 000 m
velocity of entry	8 000 m s^{-1}
velocity of landing at sea level	5.0 m s^{-1}

Assume Earth's gravitational field strength is 10 N kg^{-1}.

(a) The rocket has a mass of 22 000 kg.

(i) Calculate the deceleration of the rocket.

$(8000 ms^{-1})^2 = (5.0 ms^{-1})^2 + 2(a)(830000 m)$

$v^2 = u^2 + 2as$

$8000^2 = 5^2 + (2)(a)(830000)$

~~63999975 = 1660000a~~

$a = 3.85 m s^{-2}$

~~= 3.9 m s^-2~~

deceleration = $3.9 m s^{-2}$ [1] 0 / 1

Answer
Fnet = ma
Fnet = (22000kg)(-38.55m/s^2)
= -848100 N [1]

Incorrect computation (-1)

(ii) Calculate the resistive force acting on the rocket.

$F = ma$

$F = \cancel{22000 \times 3.86}\ 22000 kg \times 3.86 ms^{-2}$

$= 84920 N$

$= 85000 N$ (2 s.f.)

resistive force = 85000N [2] 0 / 2

Fnet = weight - resistive force
-838100 N = (22000kg)(10N/kg) - resistive force
resistive force = 1100000 N or 1.1 x 10^6 N [1]

(b) To maintain a constant deceleration, two upward forces act on the rocket during its descent. One is the force produced by the reverse thrusters.

Does not know how to compute (-2)

Name the other force and explain the relationship between this force and the force by the reverse thrusters.

~~One of~~ The other forces is the lift. The lift ~~is~~ decreases ~~and~~ as the force by the reverse thrusters decreases linearly.

[2] 0 / 2

Incorrect/incomplete explanation of how forces affected resultant force (-1)

No mention of air resistance (-1)

9 Fig. 9.1 shows a jack-in-the-box toy; a clown figurine attached to a vertical spring held in place in the box.

The vertical spring is compressed in the box. When released, the clown moves upwards as the spring extends.

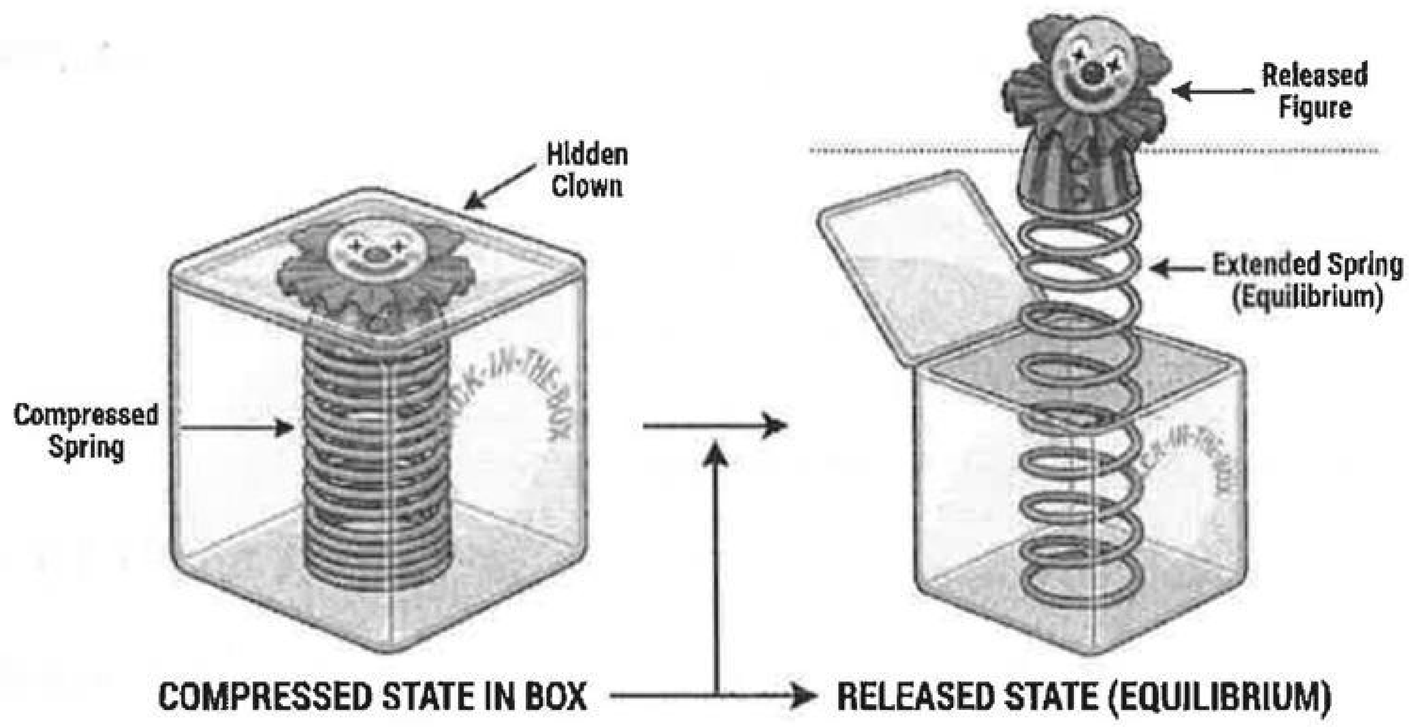


Fig. 9.1

Suggested answer
As the clown moves from the compressed position to the equilibrium position, energy is transferred from the elastic potential store to the gravitational potential store and kinetic store mechanically.
Some energy is also transferred mechanically to the internal energy store of the surroundings.

(a) State the energy store that is maximum when the spring is fully compressed.

elastic potential energy ..... [1] 1 / 1

(b) Describe the energy transfers that occur from the moment spring is released until the clown first reaches its equilibrium position.

The ~~energy~~ elastic potential store of the spring is converted to kinetic energy of the figure when the box is lifted, ~~and it~~ so it moves upwards and to heat and sound energy in the surroundings. ..... [2] 1 / 2

(c) The mass of the clown is 0.50 kg. The spring releases the clown and it rises 8.0 cm above its initial position.

one/more energy transfer not stated (-1)

Calculate the gain in energy in the gravitational potential store of the clown. Take g = 10 N kg^{-1}.

$E = mgh$

$E = 0.5kg \times 10 N kg^{-1} \times 8.0cm$
$= 40J$

~~40 ÷ 100000 = 0.00040J~~ (2 s.f)
40 J

energy in gravitational potential store = ~~0.00040J~~ ..... [2] 1 / 2

8.0 cm not converted to SI unit during computation (-1)

(d) After the release, the clown oscillates vertically before coming to a rest at the equilibrium position.

Using the concept of energy, explain why the clown stops oscillating.

The kinetic energy of the clown was converted to heat and sound energy to the surroundings. [1] 0 / 1

10 Fig. 10.1 shows a 2.0 kg ball at Position A moving with a velocity of 12 m s^{-1}. It moves down a smooth slope to Position B, then down a rough slope to Position C

incorrect/incomplete explanation (-1)

Suggested Answer
Energy is used to do work against air resistance and friction/resistive forces.

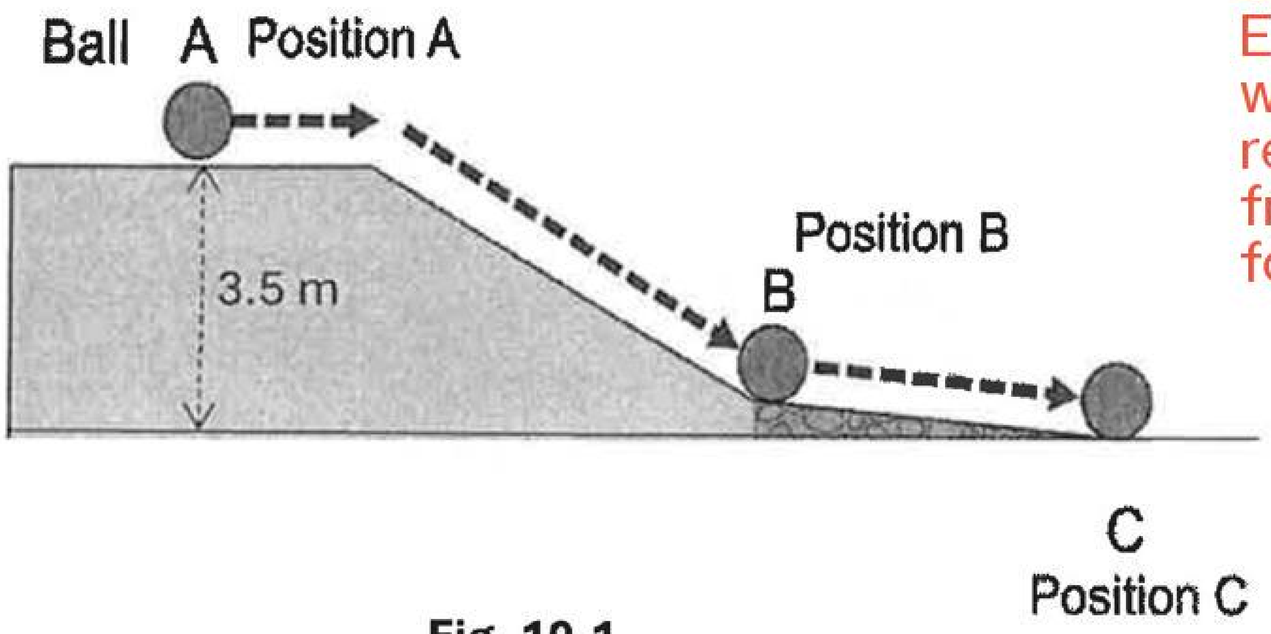


Fig. 10.1

(a) State the principle of conservation of energy.

? [1] 0 / 1

(b) Calculate the energy in the kinetic store of the ball at Position A.

Incorrect/incomplete /No definition (-1)

$E = \frac{1}{2}mv^2$

~~$E = \frac{1}{2}(2)$~~

$E = \frac{1}{2}(2.0\,kg)(12\,ms^{-1})^2$

$= 144\,J$

energy in kinetic store = 144 J [2] 2 / 2

(c) As the ball moves from Position A to Position B, it loses 60 J of energy from its gravitational potential store.

Calculate the gain in energy in the kinetic store of the ball at Position B.

E=mgh ~~144J+60J=204J~~

~~220x35~~

~~40J~~

gain in energy in kinetic store = ~~204 J~~ 60 J [1] 1 / 1

(d) After the descent from Position B to Position C, the energy that remains in the kinetic store of the ball is 100 J.

(i) If the descent takes 5.0 seconds, calculate the power generated by the frictional force along the slope.

Suggested answer
Power = Energy/time
= (70 J + 144 J - 100 J)/5.0 s
= 23W
(ok to use 140 J instead of 144 J)

~~204÷5=~~

144J+60J=204J

~~204J÷5s=40.8~~

~~=41N~~

~~52N x 2.0m =~~

power = ~~41N~~ ~~204W~~ 204 N [2] 0 / 2

(ii) The total distance along the slope from Position B to Position C is 2.0 m.

Calculate the average frictional force acting on the ball during this movement.

Suggested Answer
WD = F x d
114 J = F x 2.0 m
F = 57 N
(Ok to use 110 J instead of 114 J)

~~W=fxs~~

Wrong computation of all the energies (-1)
Wrong calculation for power (-1)

Working

average frictional force = ~~52N~~ [1] 0 / 1

(e) Another ball of the same mass is lowered vertically from Position A to the same height as Position B using a vertical string.

Compare the work done by gravity in this vertical descent to the work done by gravity when the ball is rolled down the smooth slope. Explain your reasoning.

The work done ~~by the gravi~~ by gravity is more than the vertical descent. W=fxs since the vertical ~~descent~~ descent has the smallest possible distance the displacement is smaller so less work is required. [2] 0 / 2

End of Paper

Did not recognize that vertical displacements are the same. (-1)

Did not recognise that WD is the same (-1)

Suggested answer
The work done by gravity is the same [1].

Work done by gravity depends only on the vertical height and