Mid Semester Assessment (MSA) instruction & Key Concept Review P1-P6

MSA A107 Date and time

- Date and time: **3 July Mon (2.30pm-3.30pm)**
- Inclusive of **P1-P6 → 40 marks (1 hr)**
- 3 sections:
  - MCQ (10 marks)
  - Fill in the blanks (FIB) questions (10 marks)
  - Essay questions (20 marks)
- Access to anything in their laptop including 6^{th} P (Open book)
- <u>Bounded</u> hand-written notes (A4 or smaller than A4)
- 1 piece of blank A4 size paper for workings
- No textbooks and assessment books allowed

MSA

- There are three sections in MSA

  - Section A (10 marks): MCQ Choose 1 answer

  - Section B (10 marks): FIB ______

  - Section C (20 marks): Essay → Show workings/explanations

  Total marks = 40

Section A

- MCQs
- Compulsory 10 questions.

Section B

- Fill in the blank questions.
- Compulsory questions.
- You are required to follow the instructions to put down your answer in the blanks provided.

Example of Section B question

- Qn

The speed of a car is 100 km/h, convert this speed to m/s.

Answer: 27.8________m/s

Note:

If you do not write the proper value related to the units, marks will be deducted.

Example of Section B question

- Qn

The speed of an object is 3.6 km/h, convert this speed to m/s.

Ans: <u>1________</u> m/s

Section C

- There are a few questions in Section C
- You are required to answer **All** questions in Section C. → Compulsory questions
- The question are in the form of short answer/essay questions.
- You are **required** to show your workings clearly in the space provided.

Example of Section C question

- Question C1

A car moves at a speed of 80 km/h for 120 minutes. What is the distance travelled?

Since 60 minutes is 1 hour, thus 120 minutes equals 2 hours.

Distance travelled = speed x time

Distance travelled = 80 km/h x 2 h = 160 km

Note: You are required to show detailed and clear and step by step workings (or explanations) where appropriate.

Example of Section C question

- Question C1

A car moves at a speed of 80 km/h for 120 minutes. What is the distance travelled?

The answer is 160 km.

Note: Marks will be deducted. For answer like this, it is considered incomplete without workings and proper explanations.

Tips for answering MSA

- Round off answers to 2 decimal places (but no penalty if you answer in more decimal places).
- Read the questions carefully.

Example:

Which of the following is **NOT** likely to happen?

a) Net heat flows from high to low temperatures.

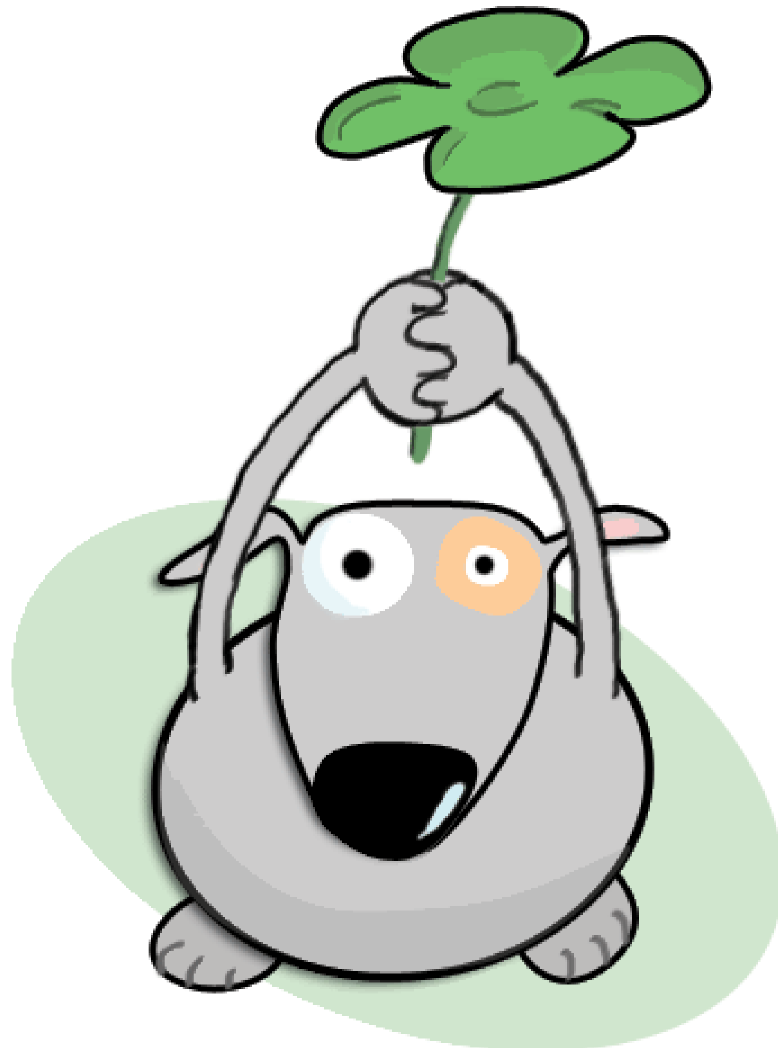
b) Net heat flows from low to high temperatures.

c) Heat flows from 36 °C to 25 °C .

Note: The question ask for something NOT likely to happen.

Tips for answering MSA

Written on Paper	**You can type in this way in your computer**
m/s^2	m/s^2
ms^{-1}	ms^-1
$\frac{1}{2}\ mv^2$	1/2 * m v^2
3×10^6 m	3 x 10^6 m



Good Luck

P01 Key Concept Recap

What are the SI base units and SI derived units?

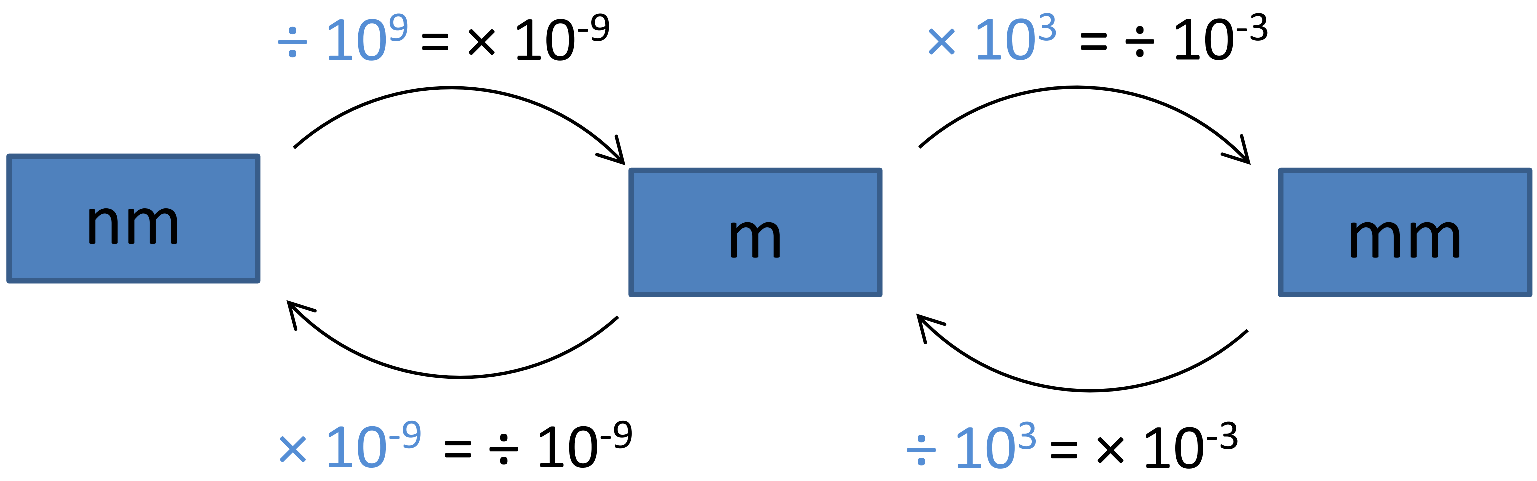
SI base quantity	SI base unit
Length	Metre (m)
Mass	Kilogram (kg)
Time	Second (s)
Electric current	Ampere (A)
Temperature	Kelvin (K)
Luminous intensity	Candela (cd)
Amount of substance	Mole (mol)

Derived quantity	Common units used	SI base unit equivalent
Area	m^2	m^2
Energy	Joule (J)	$kg \cdot m^2 \cdot s^{-2}$
Force	Newton (N)	$kg \cdot m \cdot s^{-2}$
Pressure	Pascal (Pa)	$kg \cdot m^{-1} \cdot s^{-2}$
Frequency	Hertz (Hz)	s^{-1}

How are unit conversions done effectively?

Example

- We have 1 nm = 10^{-9} m and 1 mm = 10^{-3} m
- General rule of thumb, converting from smaller to bigger units, we divide. Converting from bigger to smaller units, we multiply.



Dimension Analysis

$$E = \frac{2mv^3}{L}$$

- The SI base unit equivalent of energy E is $kg \cdot m^2 \cdot s^{-2}$.
- Thus, the SI base unit equivalent on the right hand side of the equation is $kg \cdot (ms^{-1})^3/m$. Simplifying further gives $kg \cdot m^2 \cdot s^{-3}$.
- The SI base units on both sides of the equation are different, so this equation is not valid.

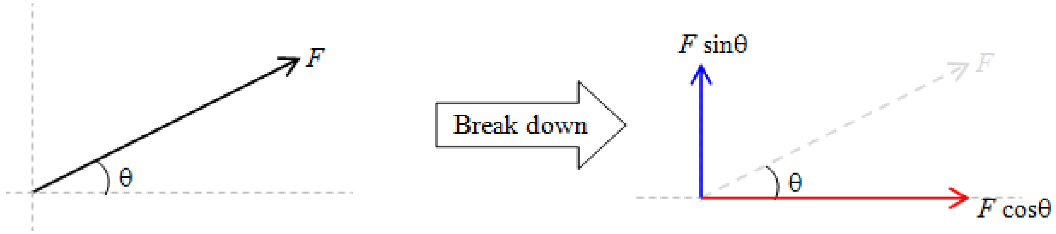
Note:

1. *Even if units are the same on both sides, equation validity still depends on the matching of the constants.*
2. *Useful quick check on equation. For example, density of water is 1g/cm^3. g comes from mass and cm^3 comes from volume → So density = mass/volume.*

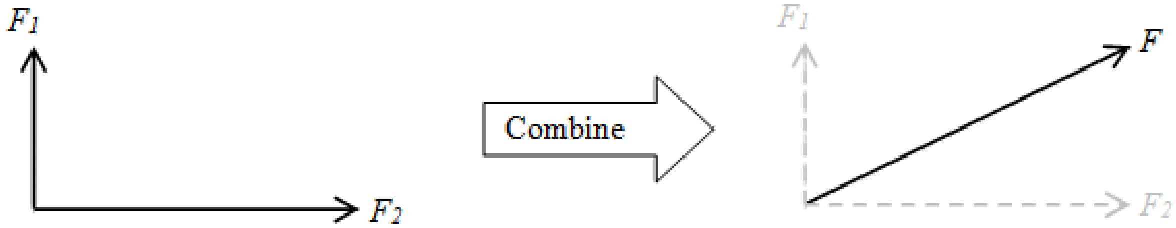
Scalar and Vectors

- A **scalar** is a physical quantity that has only magnitude but no direction.
- A **vector** is a physical quantity that has both magnitude and direction.

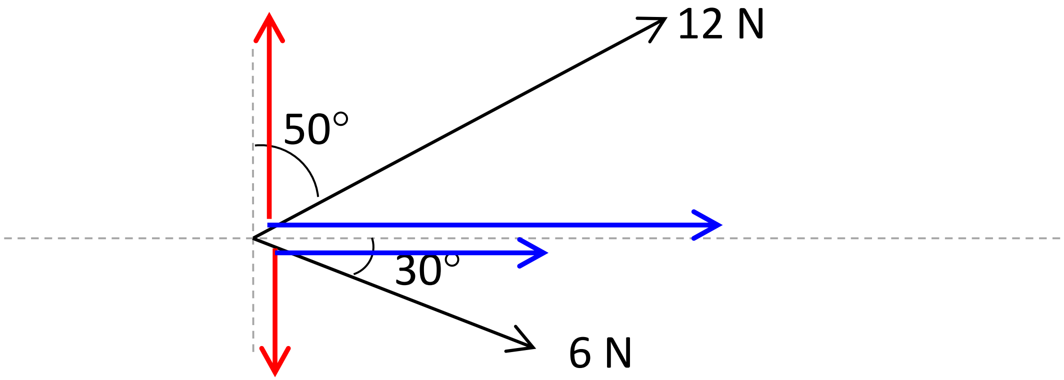
Characteristic 1:
We can resolve a vector into its perpendicular components.



Characteristic 2:
We can combine perpendicular vectors to form a single vector using Pythagoras' theorem.



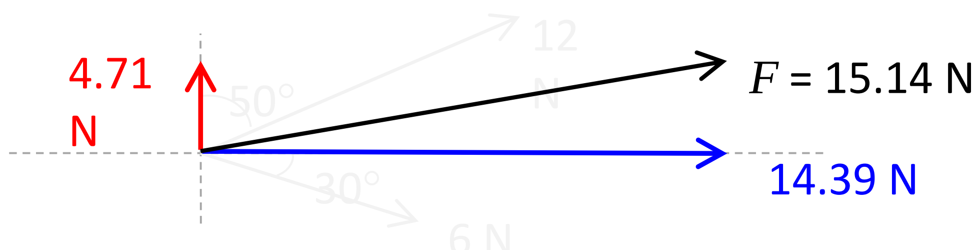
If vectors are NOT perpendicular, then how?



- We will find the vertical and horizontal components of the two forces 12 N and 6 N and add up to get the NET.

	Vertical Component	Horizontal Component
12 N	12 cos 50° = 7.71N (↑)	12 sin 50° = 9.19 N (→)
6 N	6 sin 30° = 3 N (↓)	6 cos 30° = 5.20 N (→)
Total	7.71 N – 3 N = 4.71 N (↑)	9.19 + 5.20 = 14.39 N (→)

- Then, combine perpendicular vectors to form a single vector using Pythagoras' theorem.



P02 Key Concept Recap

Distance and displacement

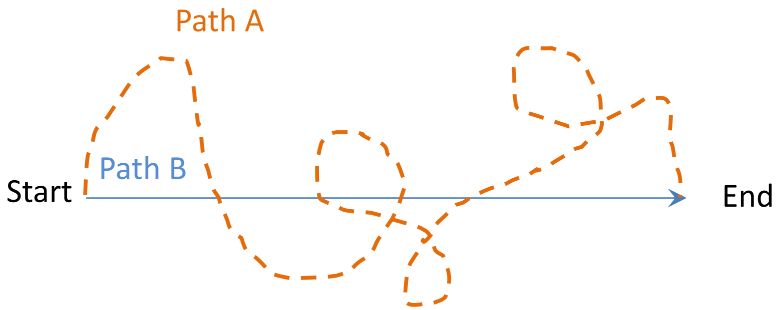


Figure 1

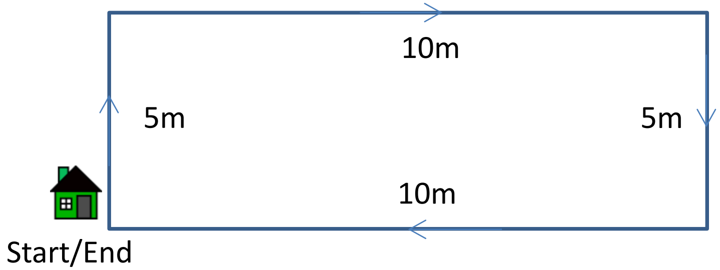


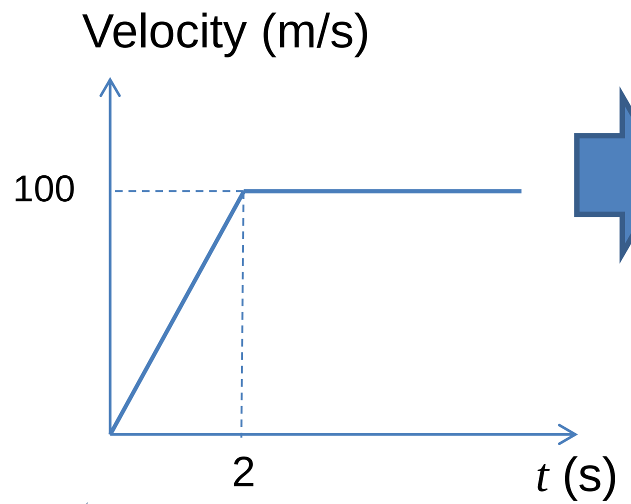
Figure 2

From Figure 1, Path A represents the distance travelled by the object.

From Figure 1, Path B represents the displacement of the object.

Hence, from Figure 2, the displacement is zero since the starting and ending position are the same.

- Sketch graphs
- Understand the relationship between displacement, velocity and acceleration



Acceleration a = **gradient** of velocity-time graph

Distance is given by area under velocity-time graph

P03/4 Key Concept Recap

Newton Laws Summary

First Law:

An object will not change its motion, be it at rest or travelling at a constant velocity unless there is a net force acting on it.

Second Law:

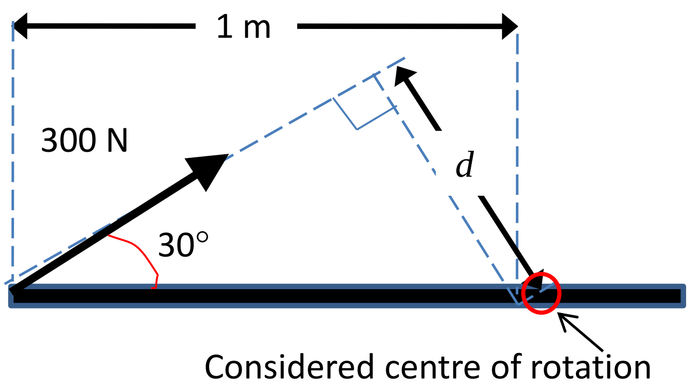
$$F_{net} = m \times a$$

Note the F_{net} and a are in the **same** direction.

Moment of a force

- The moment of a force about a point is the product of **force** and **perpendicular distance** from that reference point.
- The reference point can be **freely chosen**.

Method 1

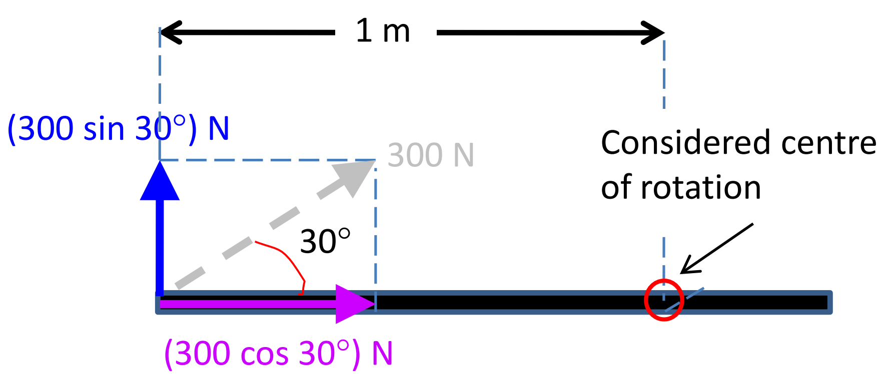


Perpendicular distance d = 1 m × sin 30°

Moment = 300 N × d

= 300 sin 30° N·m, clockwise

Method 2



300 N is first resolved into two perpendicular components.

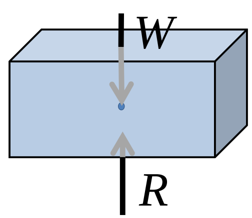
Only (300 sin 30°) N generates moment.

Moment = (300 N × sin 30°) × 1 m

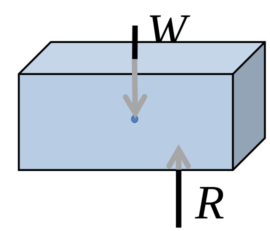
= 300 sin 30° N·m, clockwise

Condition for Static Equilibrium

- If an object is in **static equilibrium**, it will fulfil both translational equilibrium (net force = 0) and rotational equilibrium (net moment = 0)



- Object is in **static equilibrium** as (net force = 0) and (net moment = 0)

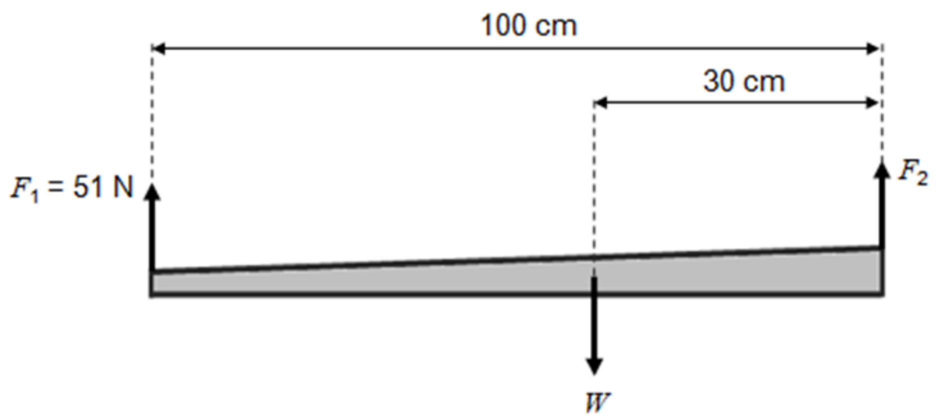


- Object is NOT in **static equilibrium** as (net force = 0) but there is a turning effect due to misalignment of forces.

Static equilibrium concept in action

A non-uniform wooden plank of length 100 cm is hung using two strings attached to both ends. The figure below shows the free-body diagram of the plank, in which F_1 and F_2 is the tension in the string at each end respectively and W is the weight of the plank. The magnitude of F_1 is 51 N and W could be considered to be acting at a point which is 30 cm away from the thicker end of the plank. The plank is in static equilibrium.

- Determine the magnitude of F_2.
- Determine the magnitude of W.



a) Using the concept of rotational equilbrium,

Taking moments about *W*,

Sum of clockwise moments = Sum of anticlockwise moments

$F_1(0.7) = F_2(0.3) \rightarrow F_2 = 119\text{N}$

b) Use the translational equilibrium concept $F_1 + F_2 = W \rightarrow W = 170$ N

Or use rotational equilibrium concept by taking moments about F_2

P05 Key Concept Recap

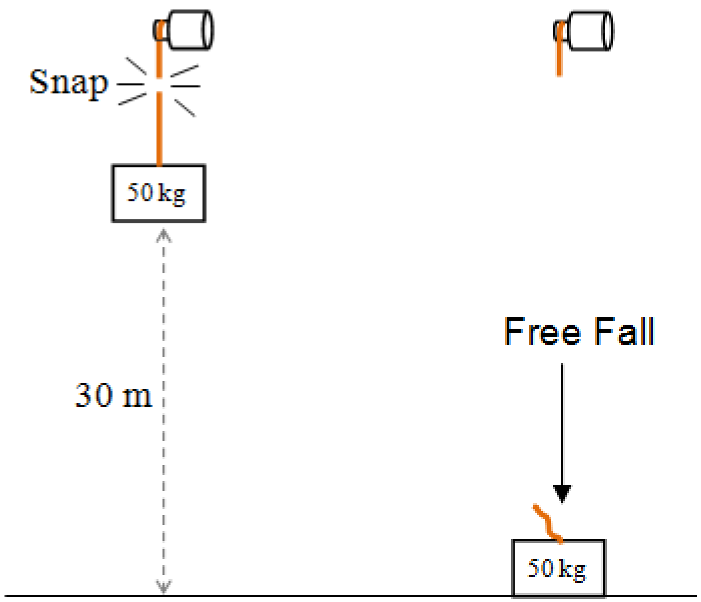
Work done = Force $\times$ distance travelled in direction of force

$$\text{Power} = \frac{\text{Work done (Energy)}}{\text{Time (s)}} = Force \times Speed$$

Energy consumed = Power $\times$ Time

Energy Conservation

- Energy can be converted from one form to another.

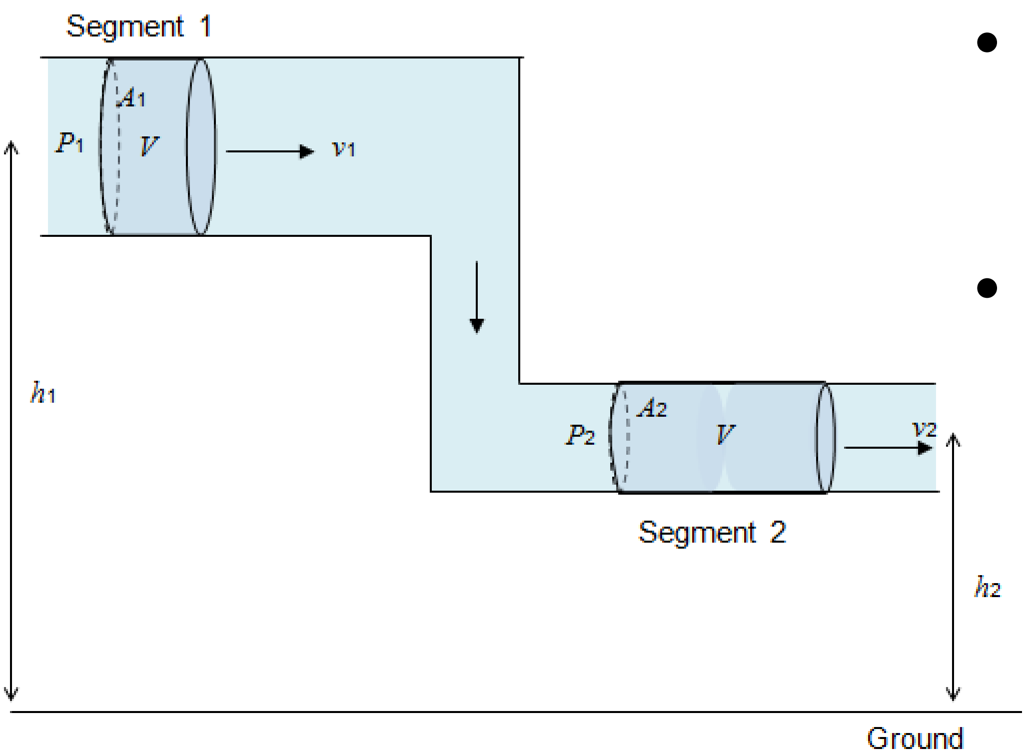


When the object is 30 m above the ground, its GPE is $50 \times 10 \times 30 = 15000$ J with respect to the ground.

When the cable snapped and the object undergoes free fall, the entire GPE of 15000 J is converted into KE the moment the object hits the ground, assuming no loss of energy in the form of heat, sound etc.

P06 Key Concept Recap

Continuity equation



- Consider the flow of a liquid in two segments of the pipe as depicted.
- In theory, if a liquid flow smoothly without bubbles forming, *the volume of the liquid that passes through any cross-section along the pipe will be the same.*

- Since the volume of the two columns of liquid is the same, we have:

$$A_1 v_1 = A_2 v_2$$

Bernoulli's principle (Qualitative approach)

When the speed of air is high, the air pressure tends to be lower. When the speed of air is low, the air pressure tends to be higher.

Bernoulli's equation (Quantitative approach)

- In a closed system, the total energy has to be the same.
- **Total energy = KE + GPE + Pressure Energy**

$$\tfrac{1}{2} m v_1^2 + m g h_1 + p_1 V = \tfrac{1}{2} m v_2^2 + m g h_2 + p_2 V$$

Substitute $m = V \times \rho$ and dividing V on both sides,

$$\boldsymbol{\tfrac{1}{2} \rho v_1^2 + \rho g h_1 + p_1 = \tfrac{1}{2} \rho v_2^2 + \rho g h_2 + p_2}$$

- If the height difference is negligible, equation can ignore gravitational potential energies and equation reduces to:

$$\boldsymbol{\tfrac{1}{2} \rho v_1^2 + p_1 = \tfrac{1}{2} \rho v_2^2 + p_2 = \text{constant.}}$$