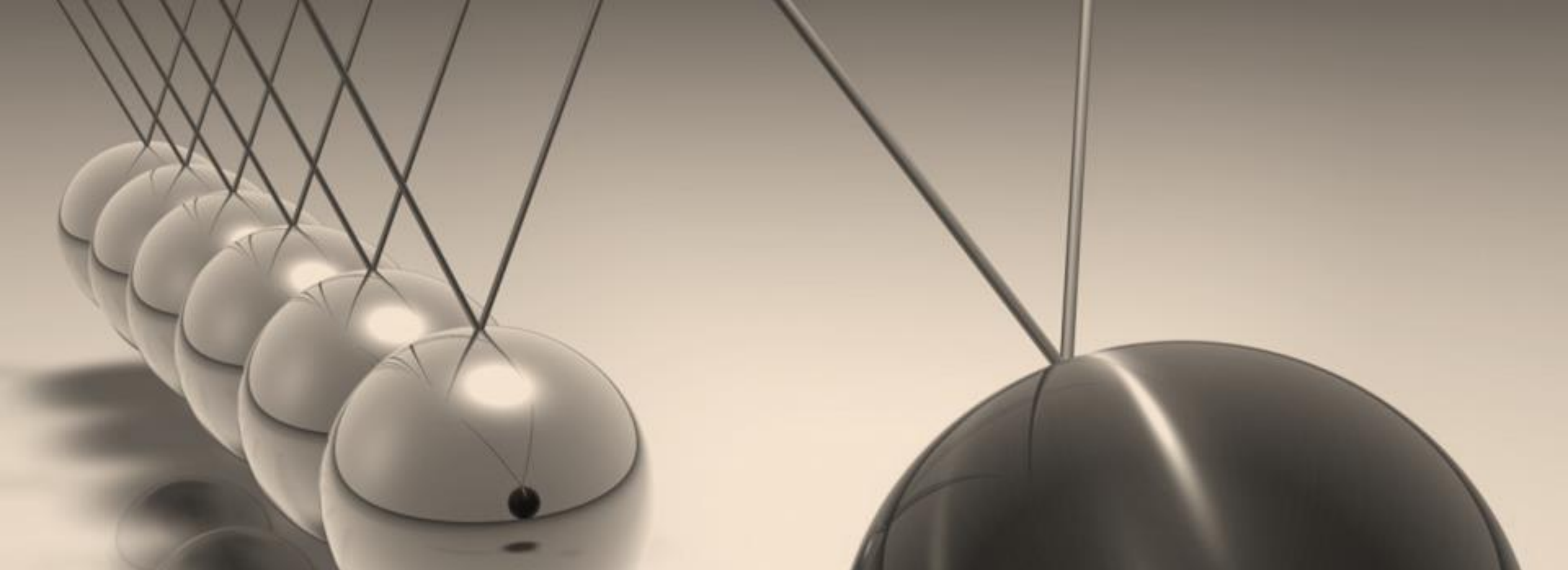


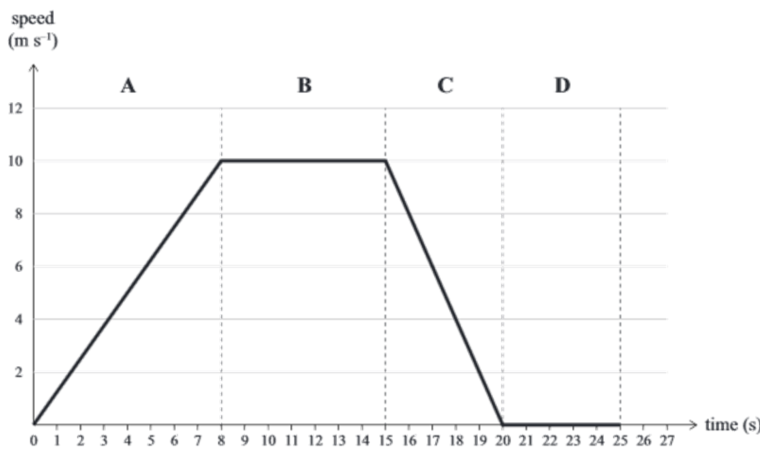
Key Question Types
NCEA Science 1.1
Mechanics AS 90940

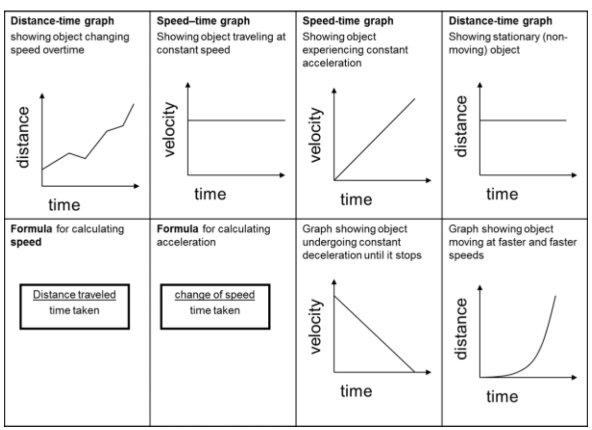
GZ Science Resources

Describing motion in Graphs

Q 1a: Describe the motion of the runner through sections A, B, C, and D.
Your answers should include descriptions AND any relevant calculations

A runner's speed is recorded for 25 seconds and graphed below.





How do we answer this question?

Section A: Accelerating at a constant rate of 1.25 m s^{-2}, from 0 m s^{-1} to 10 m s^{-1} in 8 seconds.

Check if graph is distance/time or speed/time. Link gradient of line to motion.
Back up with data or calculation

Section B: Constant speed of 10 m s^{-1} for 7 seconds.

Repeat for each section of graph

Section C: Decelerating from 10 m s^{-1} to 0 m s^{-1} at a constant rate of 2 m s^{-2} (–2 m s^{-2} if discussing acceleration) for 5 seconds.

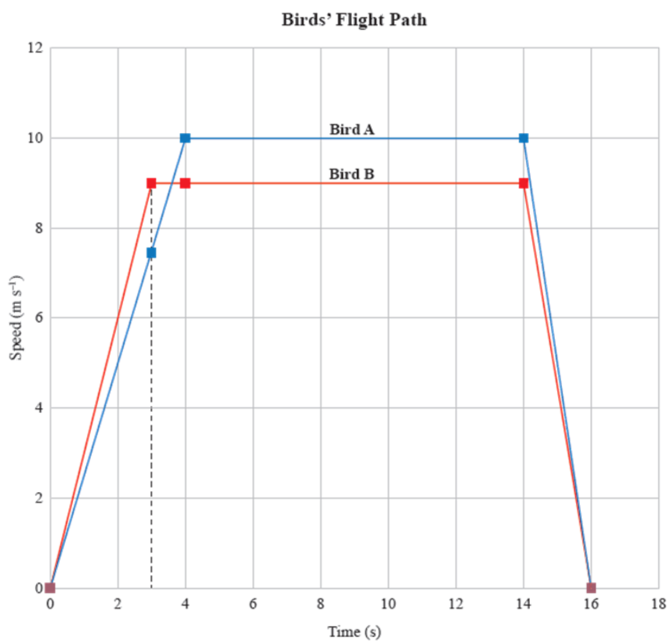
Section D: Stationary (constant speed of 0 m s^{-1}) for 5 seconds.

Make sure EVERY section is described and linked to data

GZ Science Resources

Distance from Speed/time graph

Question 2c (ii) : In 16 s, **Bird B** travelled 121.5 m. How much further did **Bird A** travel in the same time? *Show all working.*



Remember:
Area for rectangle
Base x height

Remember:
Area for triangle
½ x Base x height

How do we answer this question?

Bird A travelled:

(A) 0 – 4 s:

(B) 4 – 14 s:

(C) 14 – 16 s:

Determine the size of each section

$$d = \frac{1}{2} \times 4 \times 10 = 20 \text{ m}$$

$$d = 10 \times 10 = 100 \text{ m}$$

$$d = \frac{1}{2} \times 2 \times 10 = 10 \text{ m}$$

Calculate the area of each section (show working)

Total distance = 130 m

So Bird A has flown 8.50 m further.

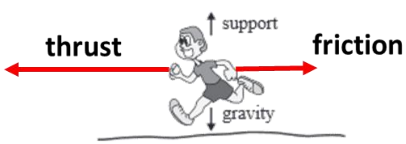
(130 – 121.5 = 8.50 m)

TOTAL area (as distance) and compare to other distance if required

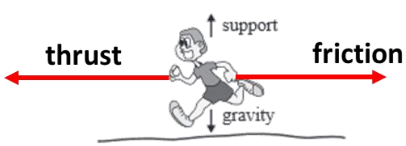
Net Force

Q 1c: Referring to your force diagrams in part (b), explain the link between the **net force** acting on the runner in sections A, B, and C of the graph, and the type of motion.
In your answer you should:
- describe what is meant by net force
- explain the link between net force and motion for EACH section
- compare the direction of the net force and the direction of the motion for EACH section.

Section A

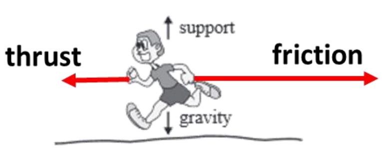


Section B



Section C

From previous question



Describe and compare each force involved

How do we answer this question?

A net force is the resultant force when multiple forces interact. If the forces are pointing in the same direction, the **forces add**, giving a larger net force. If the forces are in **opposite direction**, the **forces subtract**, giving a smaller net force (including zero)

Define NET force

Net forces determine whether the runner is accelerating, decelerating or maintaining constant speed. If the net force is pointing in the same direction as the direction of motion, the object accelerates. If the net force is pointing in the opposite direction to the direction of motion, the object decelerates. If there is no net force, the object maintains constant speed or is stationary.

Link net force to motion type and direction

Section A: The runner is accelerating. This is because there is a net force pointing forwards. This occurs when the thrust force is greater than friction.
Section B: The runner has constant speed. This is because there is no overall net force. This occurs when the thrust force is equal to friction.
Section C: The runner is decelerating. This is because there is a net force pointing in the opposite direction to the motion.

Mass and Weight

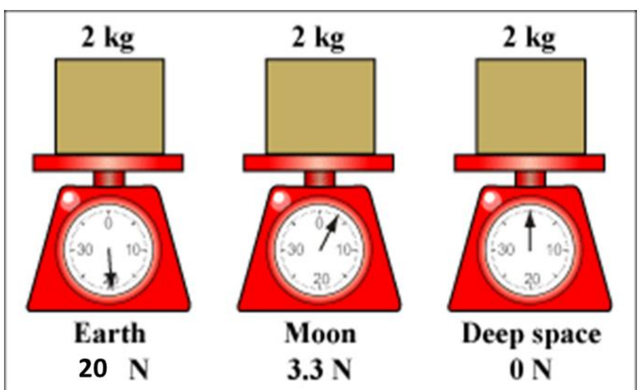
Question 2a(i) : The kererū (also known as New Zealand wood pigeon or kūkupa) is one of the largest pigeons in the world.
Explain the difference between mass and weight. Calculate the weight of a kererū that has a mass of 630 g.

Converting mass to weight

$F_w = mg$

This is still the **F = ma** formula

g = acceleration due to gravity = ($10ms^{-2}$)
Fw= Weight force (N)
m = mass (kg)



How do we answer this question?

Weight is the downward force due to gravity that an object experiences due to its mass, while mass is a measure of the amount of matter that an object has.

Define and Compare Mass with Weight

Mass does not change when location changes while weight does; (explaining) this can be given as an example of a person on the earth or on the moon.

Explain Mass does not change but weight can

Mass is measured in kg while weight is a force measured in N

$$F_w = m \times g$$
$$= 0.630 \times 10$$
$$= 6.30 \text{ N}$$

Show working and remember units

Pressure

Q 2: The father notices that his daughter on her skis has sunk further into the snow than he has on his snowboard. The father and snowboard have a combined mass of 80 kg. The daughter and the skis have a combined mass of 58 kg. Explain why the daughter on her skis sinks further into the snow than her father on his snowboard.

In your answer you should:

- calculate the pressure exerted by the daughter and her skis on the snow
- compare the pressure exerted by the daughter and father (from part (a)) on the snow
- explain the difference in pressure in terms of force AND area
- explain how pressure relates to how far the person will sink in the snow.

$F_{weight/gravity} = mg = 80 \times 10 = 800$ N

Area = $b \times h = 0.25 \times 1.6 = 0.4$ m^2

$P = F / A = 800 / 0.4 = 2\,000$ Pa (Nm^{-2})

P=F/A

P = pressure(Nm^{-2})
F = force (N)
a = area (m^2)

How do we answer this question?

Sinking depends on pressure – the greater the pressure, the further the person sinks.

$P = F/A$

Explain sinking/traction is due to pressure

A ‘lighter’ person will have less weight force than a ‘heavier’ person. However, if the ‘lighter’ person’s force is spread over a smaller area, it can produce a higher pressure than the ‘heavier’ person.

Link pressure to both weight force and area

In this example, the skis have much less area than the snowboard, so the daughter sinks further than her father, even though she is ‘lighter’.

Link pressure to example with comparison

$P_{dad} = 800/0.4 = 2\,000$ Pa

$F_{daughter} = 58 \times 10 = 580$ N $A_{daughter} = 2 \times 0.08 \times 1.75 = 0.28$ m^2

$P_{daughter} = F / A = 580 / 0.28 = 2071$ Pa

$P_{daughter} > P_{dad}$ so daughter sinks further into the snow.

Use calculations to back up statement

Work and Power

Q3c: A forklift lifts the box 4 metres straight up so it can be placed on a shelf. It takes 5 seconds to lift the box at a constant rate.
Calculate the work done to lift the box to the height of 4 m, and then calculate the power needed by the forklift to lift it to this height. .

Why does pushing an object up a ramp seem easier than lifting it straight upwards?

$W=Fd$

W = work done (J)
f = force (N)
d = distance (m)

$P=W/t$

W = work done (J)
P = power (W)
t = time (s)

How do we answer this question?

F = 25 000 N

$W = Fd$ = 25 000 × 4 = 100 000 J

$P = W / t$ = 100 000 / 5 = 20 000 W

Show working and use correct units

How do we answer this question?

The same work is required overall but going up the ramp, the push force required is only against a component of the gravity force of the bike. However, a vertical lift would require a push equal to gravity force. Therefore the force required to lift the bike straight up is greater than the force required to push it up the ramp. The distance pushing straight upwards is shorter compared to the ramp though.

Compare both Force and Distance of both

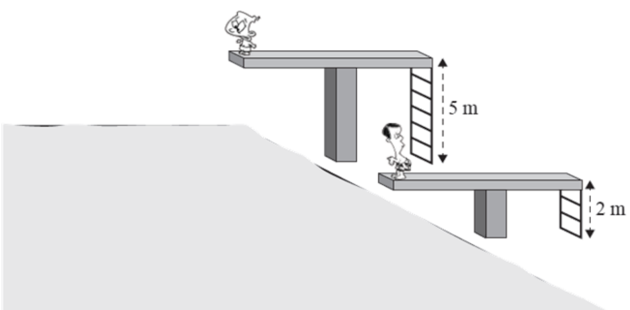
The energy gained by the bike is the same in both cases, but the time taken to go up the ramp is greater than lifting it vertically. As $P = W / t$, a greater time would mean **less power is required**.

Link power to time taken

Conservation of Energy

Question 1d: Ian jumps into the pool from the 5 m platform.
Calculate Ian's speed as he is about to hit the water (assuming conservation of energy).
In your answer you should:

- name the types of energy Ian has before he jumps, AND as he is about to hit the water
- calculate Ian's speed as he is about to hit the water.



$E_k = ½mv^2$

E_k = Kinetic energy (J)
m = mass (kg)
v = velocity (ms^{-1})

$E_p = mgh$

E_p = potential energy (J)
g = acceleration by gravity (ms^{-2})
m = mass (kg)
h = height (m)

How do we answer this question?
Ian had gained gravitational potential energy at the top of the diving board and this was converted into kinetic energy.
We assume that all gravitational potential energy will equal the kinetic energy.

If question states assuming conservation of energy then Ek = Ep

$$E_k = E_p$$
$$\frac{1}{2}mv^2 = mgh$$
$$v^2 = 2gh$$
$$v = \sqrt{2gh}$$
$$v = \sqrt{2 \times 10 \times 5}$$
$$v = 10 \text{ m s}^{-1}$$

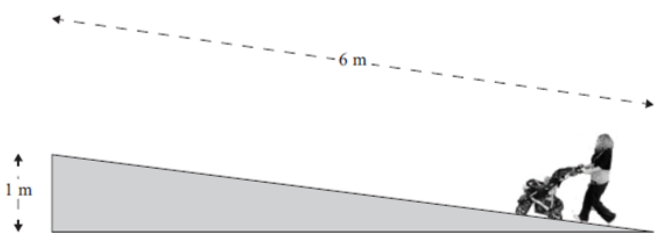
Substitute one type of energy for the other then rearrange equation to find value.

Comparing Work and Energy Difference

Q2: The energy gained by the buggy and child (m = 55 kg) at the top of the ramp **does not equal** the work done (600J). Explain why these two values are not equal.

In your answer you should:

- name the type of energy the buggy has, when it reaches the top of the ramp
- calculate the difference between the work done and the energy at the top of the ramp
- explain where the "missing" energy has gone and why this occurs.



$E_p = mgh$

E_p = potential energy (J)
g = acceleration by gravity (ms^{-2})
m = mass (kg)
h = height (m)

How do we answer this question?

Type of energy at top is **gravitational potential energy**

Statement of energy type

$Ep = mgh = 55 \times 10 \times 1 = 550$ J

Show working and use correct units

Energy difference = 600 – 550 = 50 J

Calculate energy difference between the Work and Potential energy

More energy is used to get up the ramp as some of the energy is being **converted into heat** (and sound), due to friction between the wheels and ramp, or the buggy's moving parts.

Link contact of object with surface to friction and energy converted into heat (and sound)
Link to actual question.

"Missing" Energy

GZ Science Resources

Question: A crane was lifting wood. The cable broke, and 150 kg of wood fell 12 m to the ground below. The wood had 15 000 J of kinetic energy just before it landed on the ground below. This was different from the amount of energy the wood had when it was hanging from the crane. Explain why there is a difference in the energy the wood had when it was hanging from the crane compared to just before it hit the ground.

In your answer you should:

- name the type of energy the wood had when it was hanging from the crane
- calculate how much energy the wood had when it was hanging from the crane
- calculate the difference between the kinetic energy of the wood just before hitting the ground and the energy the wood had when it was hanging from the crane
- justify the difference in energy of the wood when it was hanging from the crane and then just before it hit the ground.

How do we answer this question?

At the top, the wood has a certain amount of gravitational potential energy and no kinetic energy. Just before the wood hits the ground, the gravitational potential energy has been converted into kinetic energy.

Link type of energy to position

Some kinetic energy is lost as heat energy due to the frictional force of air resistance. (and also sound energy) so not all of the gravitational energy was remaining to convert into 100% kinetic energy

Explain that the "missing energy" was due to friction converting a portion into heat energy

$E_P = mgh = 150 \times 10 \times 12 = 18\,000$ J

Difference between E_P and E_K: $= 18\,000 - 15\,000$

$= 3\,000$ J

Use equation to demonstrate explanation