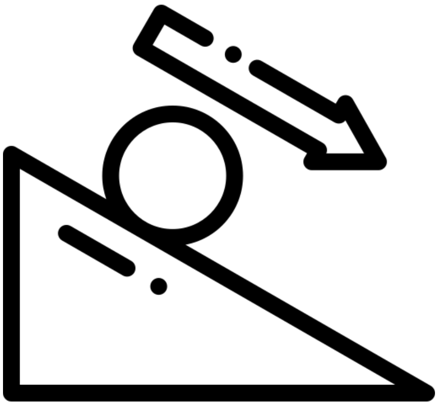
ESAT Physics Prep

Week 3 – Mechanics



ANSWERS

Week 1 – Electricity

Week 2 – Magnetism

Week 3 – Mechanics

Week 4 – Thermal physics

Week 5 – Matter

Week 6 – Waves

Week 7 – Radioactivity

There is one sample ESAT test – note that they use the same questions from NSAA 2020 specimen paper. Past NSAA & ENGAA questions are the most relevant.

There are no calculators in the ESAT.

Mechanics Spec

P3.1 Kinematics:

a. Know and understand the difference between scalar and vector quantities.

b. Know and understand the difference between distance and displacement and between speed and velocity.

c. Know and be able to apply: $\text{speed} = \dfrac{\text{distance}}{\text{time}}$,

$$\text{velocity} = \frac{\text{change in displacement}}{\text{time}}$$

d. Know and be able to apply: $\text{acceleration} = \dfrac{\text{change in velocity}}{\text{time}}$

e. Interpret distance–time, displacement–time, speed–time and velocity–time graphs.

f. Perform calculations using gradients and areas under graphs.

g. Know and be able to apply: $\text{average speed} = \dfrac{\text{total distance}}{\text{time}}$

h. Know and be able to apply the equation of motion: $v^2 - u^2 = 2as$

P3.2 Forces:

a. Understand that there are different types of force, including weight, normal contact, drag (including air resistance), friction, magnetic, electrostatic, thrust, upthrust, lift and tension.

b. Know and understand the factors that can affect the magnitude and direction of the forces in 3.2a.

c. Draw and interpret force diagrams.

d. Qualitatively understand resultant force, with calculations in one dimension.

P3.3 Force and extension:

a. Interpret force–extension graphs.

b. Understand elastic and inelastic extension, and elastic limits.

c. Know and be able to apply Hooke's law ($F = kx$), and understand the meaning of the limit of proportionality.

d. Understand energy stored in a stretched spring as: $E = \frac{1}{2}Fx = \frac{1}{2}kx^2$

P3.4 Newton's laws:

a. Know and understand Newton's first law as: 'a body will remain at rest or in a state of uniform motion in a straight line unless acted on by a resultant external force'.

b. Understand mass as a property that resists change in motion (inertia).

c. Know and understand Newton's second law as: force = mass × acceleration

d. Know and understand Newton's third law as: 'if body A exerts a force on body B then body B exerts an equal and opposite force of the same type on body A'.

P3.5 Mass and weight:

a. Know and understand the difference between mass and weight.
b. Know and be able to apply gravitational field strength, *g*, approximated as 10 N kg^{-1} on Earth.
c. Know and be able to apply the relationship between mass and weight: $w = mg$
d. Understand free-fall acceleration.
e. Know the factors affecting air resistance.
f. Understand terminal velocity and the forces involved.

P3.6 Momentum:

a. Know and be able to apply: momentum = mass × velocity, $p = mv$
b. Know and be able to use the law of conservation of momentum in calculations in one dimension.
c. Know and be able to apply: force = rate of change of momentum

NSAA 2023, Q11

11 An athlete's training session consists of several complete repetitions of a three-part programme:

1. Walk 100 m at an average speed of 6 km h^{-1} $t = \frac{0.1}{6}$ h
2. Jog 200 m at an average speed of 10 km h^{-1} $t = \frac{0.2}{10}$ h
3. Run 100 m at an average speed of 20 km h^{-1} $t = \frac{0.1}{20}$ h

What is the athlete's average speed for the complete training session, in km h^{-1}?

A 7.2

[✓ **B** 9.6]

C 11.5

D 12

E 14.4

$$\text{Total } t = \frac{0.1}{6} + \frac{0.2}{10} + \frac{0.1}{20}$$

$$= \frac{1}{60} + \frac{1.2}{60} + \frac{0.3}{60}$$

$$= \frac{2.5}{60}$$

$$v = \frac{s}{t} = \frac{0.4}{\frac{2.5}{60}} = \frac{24}{2.5} = 9.6 \text{ m/s}$$

NSAA 2023, Q21

$W = mg \Rightarrow g = \frac{W}{m}$

21 An object has mass m and weight W on the Moon. The Moon has no atmosphere.

The object is released from rest at height h above the surface of the Moon.

Which expression gives the speed of the object as it reaches the surface?

A $\frac{Wh}{m}$

B $\frac{2Wh}{m}$

C $\frac{2mh}{W}$

D $2mWh$

E $\sqrt{2mWh}$

F $\sqrt{\frac{Wh}{m}}$

[✓ **G**] $\sqrt{\frac{2Wh}{m}}$

H $\sqrt{\frac{2mh}{W}}$

$\cancel{m}gh = \frac{1}{2}\cancel{m}v^2$

$v = \sqrt{2gh}$

$= \sqrt{\frac{2Wh}{m}}$

NSAA 2023, Q22

22 A spaceship of mass 10 000 kg is moving at 2.0 m s^{-1} relative to a space station.

The spaceship is captured by a robotic arm attached to the space station and brought to rest by a force of 1000 N. $\hookrightarrow a = \frac{F}{m} = \frac{1000}{10000} = 0.1\ m/s^2$

How far will the spaceship move in its initial direction relative to the space station while the force is being applied?

(Assume that the acceleration of the space station is negligible.)

A 0.050 m

B 0.10 m

C 0.20 m

D 5.0 m

E 10 m

[✓ **F** 20 m]

s – s
u – 2.0
v – 0
a – -0.1
t – X

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

$0 = 4.0 - 0.2s$

$s = \frac{4.0}{0.2} = 20\ m$

NSAA 2023, Q25

25 A car travels for a total time of 20 s. For the first *t* seconds its speed is 5.0 m s^{-1} and for the remainder of the journey its speed is 10 m s^{-1}.

The average speed for the whole journey is 8.5 m s^{-1}.

What is the value of *t*?

A 3.0

[✓ **B** 6.0]

C 10

D 17

E $\frac{20}{3}$

F $\frac{40}{3}$

average $v = \frac{s}{t}$ $\quad 8.5 = \frac{s}{20}$

$s = 8.5 \times 20 = 170m$

$$\underbrace{5.0t}_{\text{distance in first } t \text{ seconds}} + \underbrace{10(20-t)}_{\text{distance in } 20-t \text{ seconds}} = 170$$

$-5.0t + 200 = 170$

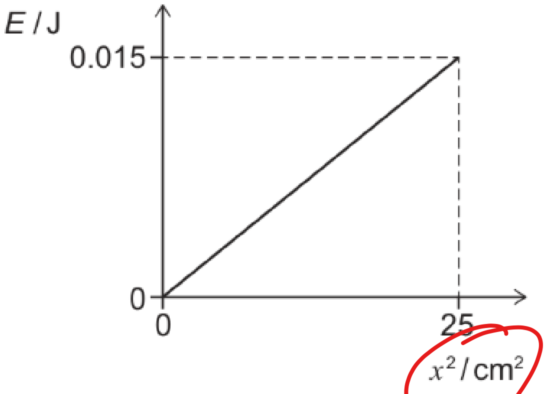
$-5.0t = -30$

$t = 6.0s$

NSAA 2023, Q26

26 A spring is initially unstretched. A force F is used to stretch the spring. The extension x and the energy E stored in the stretched spring are measured for different values of F.

The graph shows how the energy E, in J, varies with the extension squared, x^2, in cm^2.



$x = 5\text{cm}$

What is the magnitude of F when the spring stores 0.015 J of energy?

$E = \frac{1}{2} F x$

$F = \frac{2E}{x} = \frac{2 \times 0.015}{0.05}$

$= 0.60\text{N}$

A 0.30 N

[✓ **B** 0.60 N]

C 1.2 N

D 1.5 N

E 2.4 N

F 3.0 N

G 30 N

H 60 N

NSAA 2023, Q31

31 Two stones are held at rest at the same height at the top of a cliff.

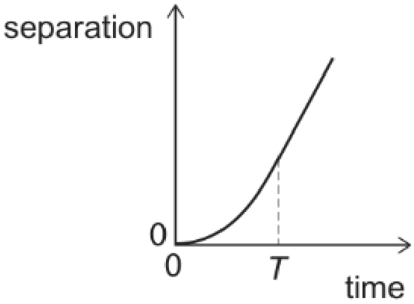
One stone is released and falls freely under gravity.

A time T later, the other stone is released and falls freely under gravity.

Which graph shows how the vertical distance separating the stones varies with time, from the moment the first stone is released and before the first stone lands?

(Assume that air resistance is negligible.) → constant acceleration

[✓ **A**]



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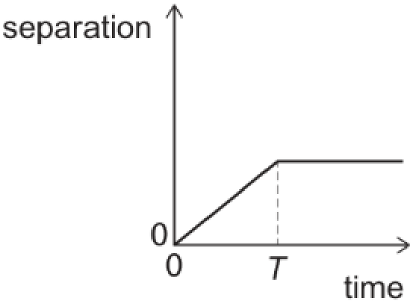

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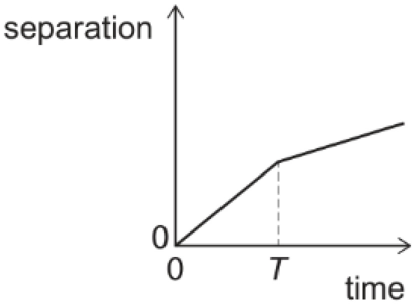

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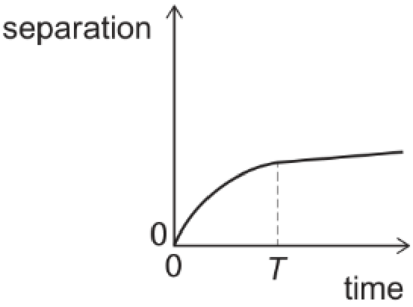
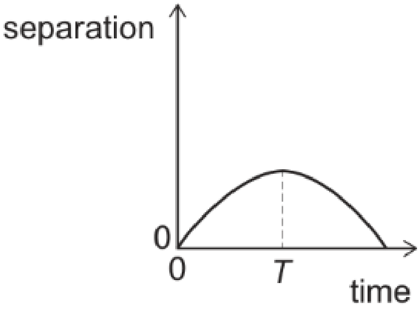
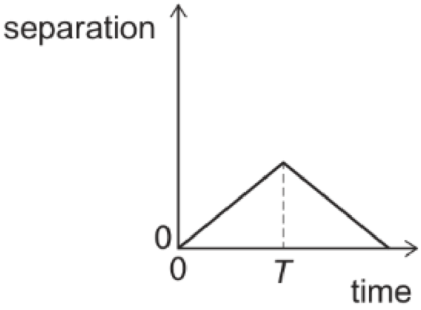


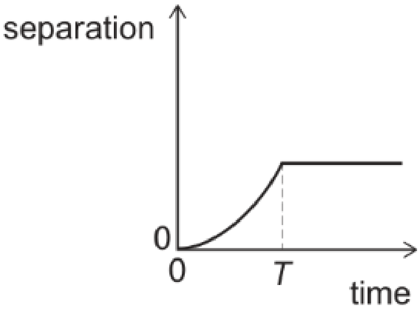
E



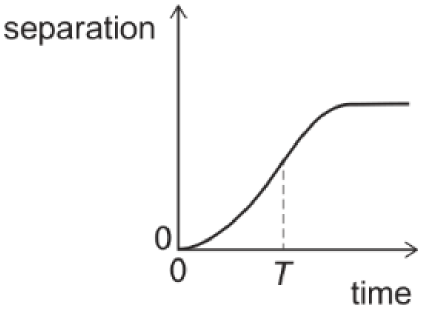
F



G



H



NSAA 2022, Q25

25 A small piece of space debris of mass 0.10 g strikes the International Space Station at a relative speed of 15 000 m s^{-1}.

The piece of debris comes to rest relative to the space station in a time of 0.010 s.

What is the average force exerted on the space station by the piece of debris during this time?

A 0.0010 N

B 1.0 N

C 1.5 N

D 100 N

[✓ **E** 150 N]

F 1500 N

$$F = \frac{m\Delta v}{\Delta t} = \frac{0.10 \times \frac{1}{100} \times 15000}{0.010}$$

$$= \frac{0.10 \times 15}{0.010}$$

$$= 10 \times 15 = 150\,N$$

NSAA 2022, Q26

26 A block of mass 6.0 kg is pushed along a rough horizontal surface by a constant force of 8.0 N. The block accelerates uniformly from rest. After 4.0 s its velocity is 2.0 m s^{-1}.

How much work is done against resistive forces during this 4.0 s?

A 12 J

[✓ **B** 20 J]

C 24 J

D 32 J

E 40 J

F 64 J

$$s = \frac{1}{2}(u+v)t = \frac{2.0}{2} \times 4.0$$

$$= 4.0\,m$$

$$W = Fs = 8.0 \times 4.0 = 32\,J$$

$$KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 6.0 \times 4$$

$$= 12\,J$$

$$32 - 12 = 20\,J$$

NSAA 2022, Q31

31 A child is bouncing a ball of mass 0.16 kg vertically up and down on a bat. Each time the ball hits the bat the duration of the contact is 0.20 s. The speed of the ball immediately before hitting the bat and immediately after it loses contact with the bat is 4.0 m s^{-1}. $\Delta v = 8.0$

What is the average contact force between the bat and the ball during each collision?

(gravitational field strength = 10 N kg^{-1})

A 1.6 N

B 3.2 N

C 4.8 N

D 6.4 N

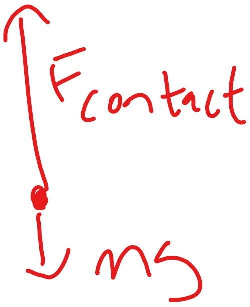
[✓ **E** 8.0 N]

$$F_{net} = \frac{m\Delta v}{\Delta t} = \frac{0.16\times 8.0}{0.20}$$

$$= 0.16\times 8.0\times 5$$

$$= 0.16\times 40$$

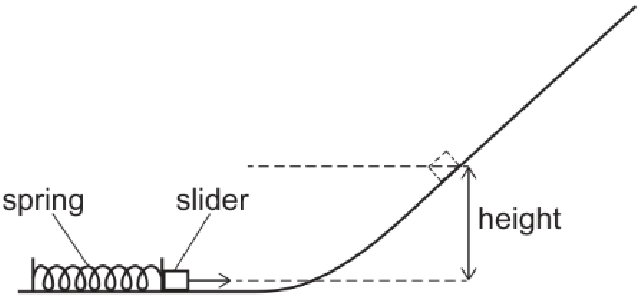
$$= 6.4N$$



$$F_{contact} = 6.4 + 1.6 = 8.0$$

NSAA 2022, Q37

37 A small slider of mass 30 g is at rest near the bottom of a frictionless slope and in contact with a light uncompressed spring as shown.



[diagram not to scale]

The spring is compressed by 5.0 cm and the slider remains in contact with it.

The spring is released and causes the slider to rise up the slope to a maximum vertical height of 20 cm.

The slider is replaced with one of mass 20 g.

×3 extension so ×9 EPE

The spring is now compressed by 15 cm, and the new slider remains in contact with it.

To what maximum vertical height does this new slider rise after it is released?

(the spring obeys Hooke's law; assume that air resistance is negligible)

height $\times \frac{3}{2}$

A 40 cm

B 60 cm

C 90 cm

$20 \times 9 \times \frac{3}{2} = 10 \times 9 \times 3$

$= 270$ cm

D 120 cm

E 180 cm

F [✓ 270 cm]

NSAA 2021, Q24

24 A car of mass 1400 kg is towing a caravan of mass 1000 kg along a straight horizontal section of road at a constant speed.

→ no acceleration

The driving force from the engine is increased by 3000 N, causing the car and caravan to accelerate.

At one moment during this acceleration, the resistive force on the car has increased by 200 N and the resistive force on the caravan has increased by 400 N.

What is the acceleration of the car and caravan at this moment?

[✓ **A** 1.00 m s^{-2}]

B 1.25 m s^{-2}

C 1.50 m s^{-2}

D 2.00 m s^{-2}

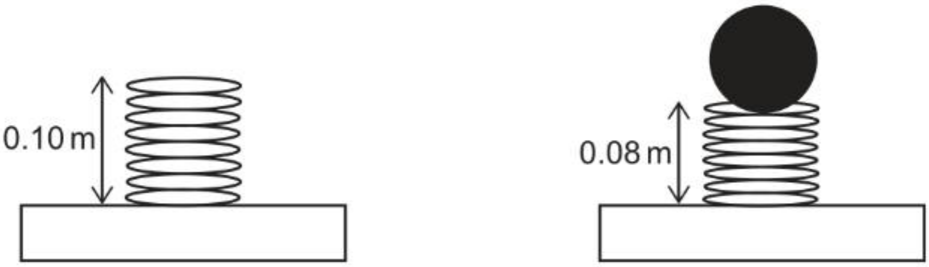
E 2.60 m s^{-2}

2400N more force

$$a = \frac{F}{m} = \frac{2400}{2400} = 1.0 \, m/s^2$$

NSAA 2021, Q27

27 A light spring has an uncompressed length of 0.10 m. When an object of mass 0.5 kg rests in equilibrium on top of the spring, the length of the spring reduces to 0.08 m as shown.



What is the energy stored in the spring due to the compression?

(gravitational field strength = 10 N kg^{-1}; the spring obeys Hooke's law)

A 0.005 J

B 0.02 J

[✓ **C** 0.05 J]

D 0.1 J

E 0.2 J

F 0.4 J

$$E = \frac{1}{2} Fe$$

$$= \frac{1}{2} \times 5 \times 0.02$$

$$= 5 \times 0.01$$

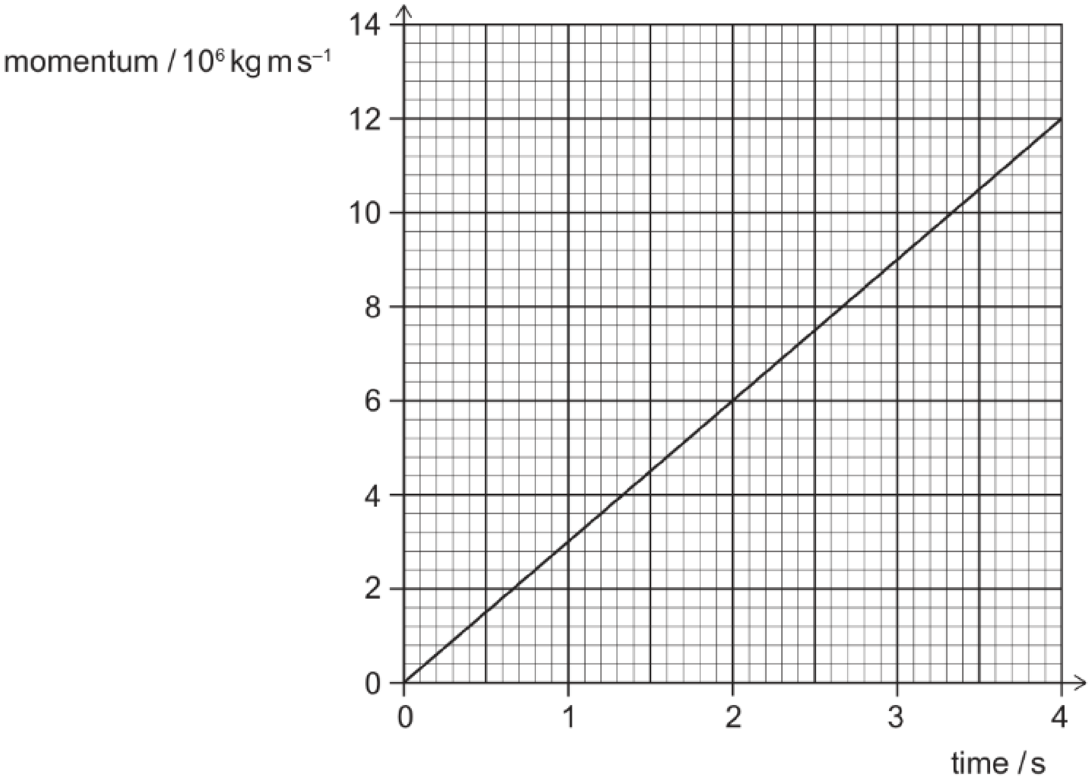
$$= 0.05 \, J$$

NSAA 2021, Q29

29 A train accelerates from rest along a straight, horizontal section of track.

The force exerted on the train due to its motors is constant and there is a constant friction force of 1.8×10^7 N.

The graph shows how the momentum of the train changes with time.



What is the force exerted on the train due to its motors?

A 3.0×10^6 N

B 6.0×10^6 N

C 1.2×10^7 N

D 1.5×10^7 N

[✓ **E** 2.1×10^7 N]

F 2.4×10^7 N

G 3.0×10^7 N

H 4.2×10^7 N

$$F = \frac{\Delta p}{\Delta t} = \frac{12 \times 10^6}{4}$$

$$= 3 \times 10^6 \text{ N}$$

This is in addition to resistive force

$$(1.8 \times 10^7) + (0.3 \times 10^7)$$

$$= 2.1 \times 10^7 \text{ N}$$

NSAA 2021, Q34

34 There is a high-speed straight railway line between two cities that are 60 km apart. The train stops at both cities.

The train accelerates at a uniform rate of 1.5 m s^{-2} to a maximum speed of 120 m s^{-1}.

When braking, it decelerates at a uniform rate of 2.0 m s^{-2}.

What is the minimum time taken by the train to travel from one city to the other?

A 140 s

B 355 s

C 430 s

D 500 s

[✓ **E** 570 s]

F 860 s

G 1000 s

80s to 120 m/s

60s from 120 to 0 m/s

Distance in 80s = $\frac{1}{2} \times 80 \times 120$

$= 40 \times 120$

$= 4800$ m

Distance in 60s = $\frac{1}{2} \times 60 \times 120 = 3600$ m

$60 - (4.8 + 3.6) = 51.6$ km

$t = \frac{s}{v} = \frac{51600}{120} = 430$ s

$430 + 80 + 60$
$= 570$ s

NSAA 2021, Q36

36 A skydiver of mass 80 kg is accelerating vertically downwards through the air. At one instant in time the skydiver has a speed of 5.0 m s^{-1}. After travelling a further distance of 20 m downwards the skydiver's speed has increased to 10 m s^{-1}.

What is the average force of air resistance acting on the skydiver over the 20 m?

(gravitational field strength = 10 N kg^{-1})

A 600 N

[✓ **B** 650 N]

C 750 N

D 790 N

E 950 N

s - 20
u - 5.0
v - 10
a - a
t - t

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

$100 = 25 + 2a \times 20$

$75 = 40a$

$a = \frac{75}{40}$

Resultant force down = $F = m \times a = 80 \times \frac{75}{40} = 150$ N

weight = 800 N

$800 - 150 = 650$ N

NSAA 2020, Q32

32 Two trolleys are moving towards each other along a straight horizontal track.

One trolley has mass 8.0 kg and is travelling to the right at 4.0 m s^{-1}.

The other trolley has mass 2.0 kg and is travelling to the left at 1.0 m s^{-1}.

When the trolleys collide they stick together.

How much kinetic energy is transferred to other forms of energy in the collision?

A 2.0 J
B 18 J
[✓ **C** 20 J]
D 28 J
E 35 J
F 40 J
G 45 J
H 65 J

Initial KE $= \frac{1}{2} \times 8 \times 4^2$
$+ \frac{1}{2} \times 2 \times 1^2$
$= 64 + 1 = 65$ J

Initial mom $= (8 \times 4) - (2 \times 1)$
$= 30$ kgm/s

Final mom $= 30 = 10 \times v$
$v = 3$ m/s

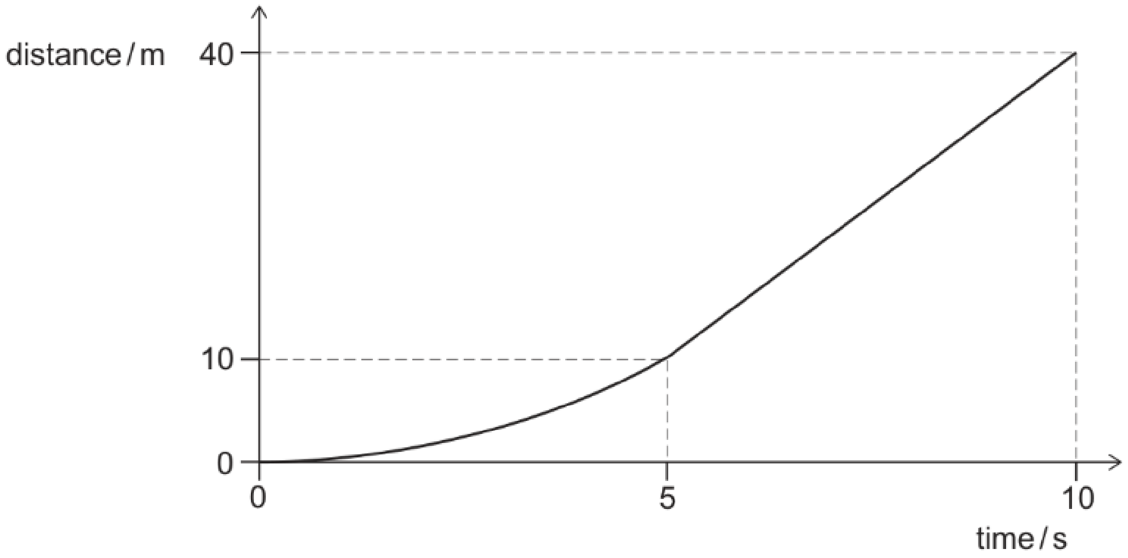
Final KE $= \frac{1}{2} \times 10 \times 3^2$
$= 45$ J

$65 - 45 = 20$ J

NSAA 2020, Q33

33 A car of mass 800 kg travels in a straight line along a horizontal road.

The car accelerates **non-uniformly** from rest for 5.0 seconds and then moves at constant speed, as shown in the distance–time graph:



What is the average resultant force acting on the car over the time for which it is accelerating?

What is the average resultant force acting on the car over the time for which it is accelerating?

- **A** 320 N
- **B** 480 N
- [✓ **C** 640 N]
- **D** 960 N
- **E** 1600 N
- **F** 3200 N
- **G** 4800 N

↳ need average acceleration

s - 10
u - 0
v -
a - a
t - 5

$s = ut + \frac{1}{2}at^2$

$10 = 0 + \frac{a}{2} \times 25$

$20 = 25a$ $a = \frac{20}{25}$

$= 0.8 m/s^2$

$F = ma$

$= 800 \times 0.8 = 640 N$

NSAA 2020, Q38

38 A parachutist of mass 80.0 kg drops from a plane travelling at 40.0 m s^{-1}, 2000 m above the Earth's surface.

The parachutist hits the ground at a speed of 5.00 m s^{-1}.

How much work is done by the parachutist against drag forces during the fall?

(Take the Earth's gravitational field strength to be 10.0 N kg^{-1}.)

A 1 535 000 J

B 1 624 000 J

C 1 649 000 J

[✓ **D** 1 663 000 J]

E 1 726 000 J

Initial KE $= \frac{1}{2} \times 80 \times 40^2$
$= 40 \times 40^2 = 40 \times 1600$
$= 64000$ J

$mgh = 80 \times 10 \times 2000$
$= 800 \times 2000 = 1600\,000$ J

Final KE $= \frac{1}{2} \times 80 \times 25$
$= 40 \times 25$
$= 1000$ J

Lost 1663 000 J

NSAA 2020, Q39

39 A light spring of unstretched length 0.10 m has a spring constant of 20 N m^{-1}. The spring is suspended so that it is vertical and a load of mass 0.050 kg is attached to the end of the spring.

The load is pulled vertically downwards until the length of the spring is 0.30 m. The load is then released.

What is the speed of the load at the instant that the spring returns to its unstretched length?

(gravitational field strength = 10 N kg^{-1}; assume that resistive forces are negligible)

A 0 m s^{-1}

B 4.0 m s^{-1}

C 6.0 m s^{-1}

D 12 m s^{-1}

E 16 m s^{-1}

F $\sqrt{6}$ m s^{-1}

[✓ **G** $\sqrt{12}$ m s^{-1}]

H $\sqrt{30}$ m s^{-1}

EPE gained $= \frac{1}{2} ke^2$
$= \frac{1}{2} \times 20 \times 0.20^2$
$= 10 \times 0.04$
$= 0.4$ J

GPE lost $= mgh = 0.05 \times 10 \times 0.2$
$= 0.5 \times 0.2$
$= 0.1$ J

KE gained $= 0.3 = \frac{1}{2} mv^2$

$0.3 = \frac{1}{2} \times 0.05 \times v^2$

$v^2 = \frac{0.6}{0.05} = 12$

$v = \sqrt{12}$ m/s

NSAA 2020, Q40

→ less mass

40 A rocket travelling in space is burning its fuel at a constant rate. By expelling the burnt fuel through a nozzle, the engine is applying a constant force to the rocket.

What is happening to the magnitude of the acceleration of the rocket?

[✓ **A**] It is increasing at an increasing rate.

B It is increasing at a constant rate.

C It is increasing at a decreasing rate.

D It is not changing.

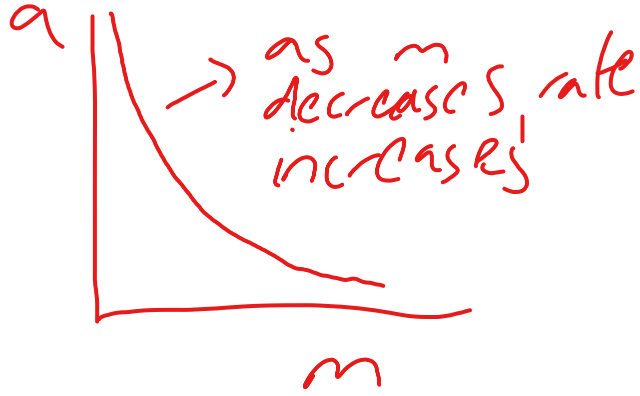
E It is decreasing at an increasing rate.

F It is decreasing at a constant rate.

G It is decreasing at a decreasing rate.

$$F = \overset{\downarrow}{m}\overset{\uparrow}{a}$$

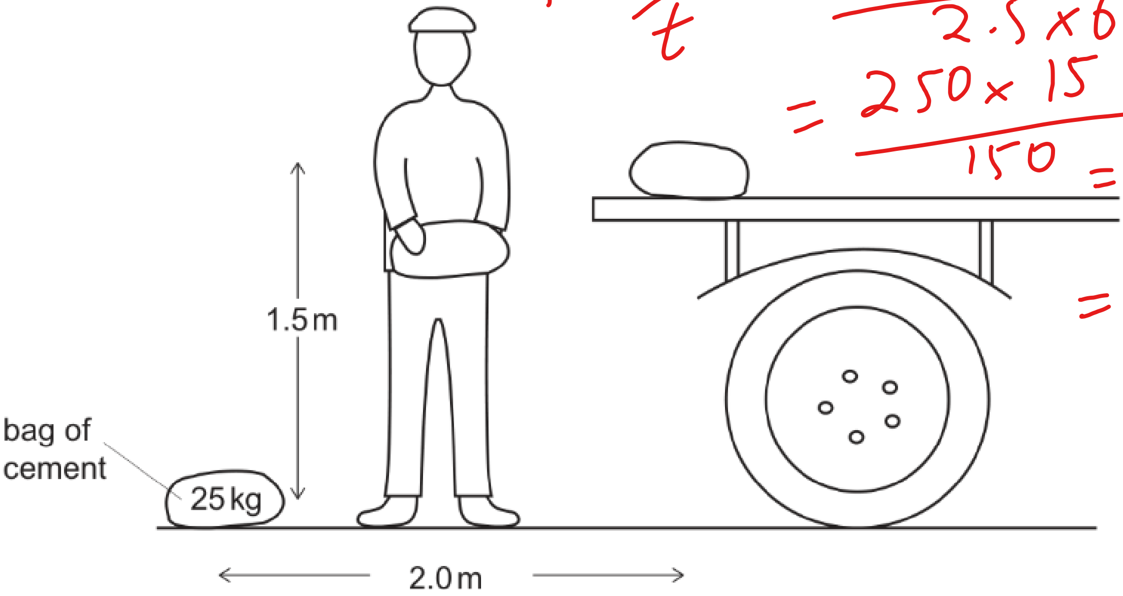
$$a = \frac{1}{m}$$



NSAA 2019, Q20

20 A builder lifts bags of cement onto the back of a lorry. Each bag has a mass of 25 kg. It takes the builder 2.5 minutes to load ten bags.

$$P = \frac{W}{t} = \frac{25 \times 10 \times 10 \times 1.5}{2.5 \times 60} = \frac{250 \times 15}{150} = \frac{3750}{150} = 25W$$



[diagram not to scale]

What are the total work done, *T*, on the ten bags and the average power required for *T*?

(gravitational field strength = 10 N kg^{-1})

	total work done T / J	*average power / W*
A	375	2.5
B	375	150
C	625	4.2
D	625	250
[✓ **E**]	3750 ✓	25 ✓
F	3750 ✓	1500 ✗
G	6250	42
H	6250	2500

NSAA 2019, Q24

24 A light spring is used to support a range of loads.

The spring obeys Hooke's law. The system is in equilibrium.

Which of the following statements is/are correct?

extension

1 The tension in the spring is directly proportional to the length of the spring. ✗

2 The tension in the spring and the weight of the load it supports are a Newton's third law pair of forces. ✗ Not of same type

3 When the extension of the spring is doubled, the energy stored in the spring increases by a factor of four. ✓

$EPE = \frac{1}{2}kx^2$

A none of them

B 1 only

C 2 only

[✓ **D**] 3 only

E 1 and 2 only

F 1 and 3 only

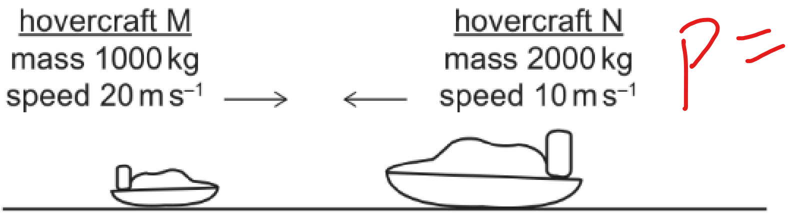
G 2 and 3 only

H 1, 2 and 3

NSAA 2019, Q33

33 Two hovercraft travel horizontally in opposite directions along the same straight line. The mass and speed of each hovercraft are shown in the diagram. Horizontal resistive forces acting on each hovercraft are negligible.

$p = 20000 \text{ kgm/s}$



$p = -20\ 000 \text{ kgm/s}$

The hovercraft collide and stick together. The collision lasts for 0.10 s.

$F = m\Delta v / \Delta t = \frac{20000}{0.10} = 200\ 000 \text{ N}$

Just before the collision, what is the total kinetic energy and the magnitude of the total momentum of the two hovercraft, and what is the magnitude of the average force acting horizontally on each hovercraft during the collision?

	total initial kinetic energy / kJ	*total initial momentum* / kg m s^{-1}	*average force on each hovercraft* / kN
A	100 ✗	0 ✓	2.0
B	100 ✗	0 ✓	200
C	100 ✗	4.0×10^4 ✗	2.0
D	100 ✗	4.0×10^4 ✗	200
E	300 ✓	0 ✓	2.0 ✗
[✓ **F**]	300 ✓	0 ✓	200 ✓
G	300 ✓	4.0×10^4 ✗	2.0
H	300 ✓	4.0×10^4 ✗	200

$$KE = \left(\tfrac{1}{2} \times 1000 \times 20^2\right) + \left(\tfrac{1}{2} \times 2000 \times 10^2\right)$$

$$= 500 \times 400 + 1000 \times 100$$

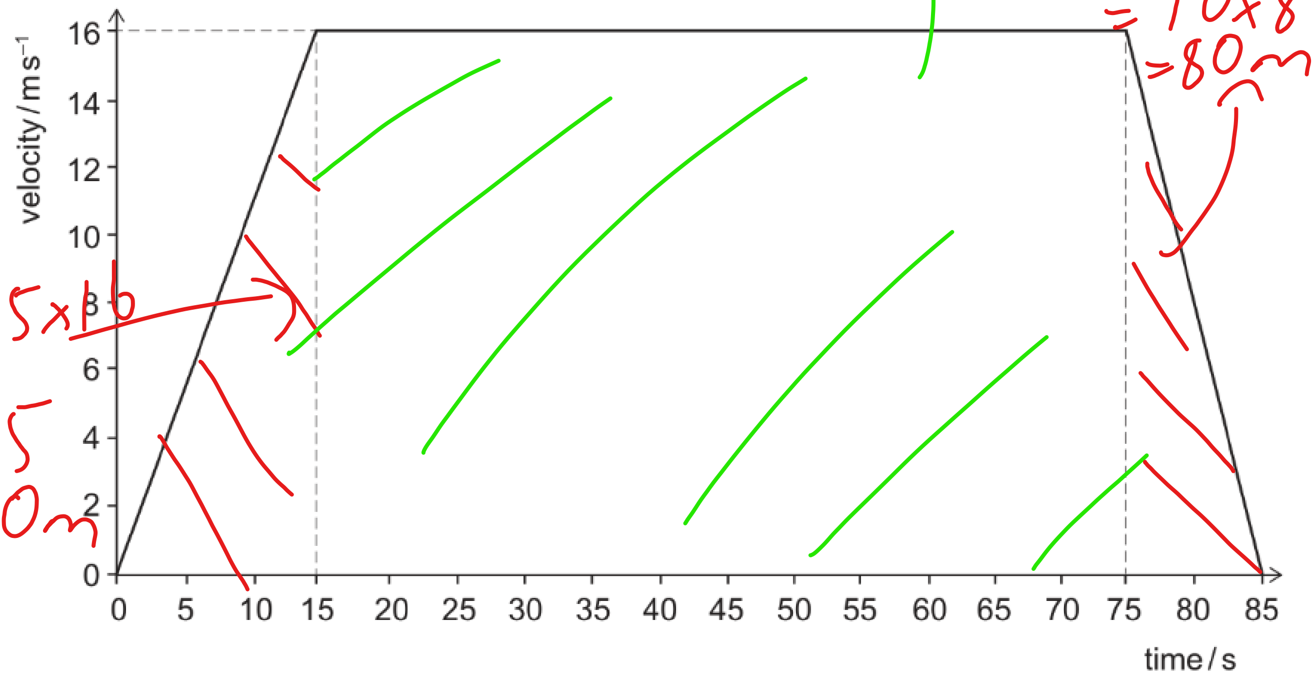
$$= 200\ 000 + 100\ 000 = 300\ 000 \text{ J}$$

NSAA 2019, Q34

$s = 60 \times 16 = 960\text{m}$

$s = \frac{1}{2} \times 10 \times 16 = 10 \times 8 = 80\text{m}$

34 The graph shows how a car's velocity changes in 85 seconds.



$s = \frac{1}{2} \times 15 \times 16 = 8 \times 15 = 120\text{m}$

What proportion of the total distance is travelled at constant velocity?

What proportion of the total distance is travelled at constant velocity?

A $\frac{5}{29}$

B $\frac{5}{17}$

C $\frac{12}{17}$

[✓ **D**] $\frac{24}{29}$

E $\frac{8}{9}$

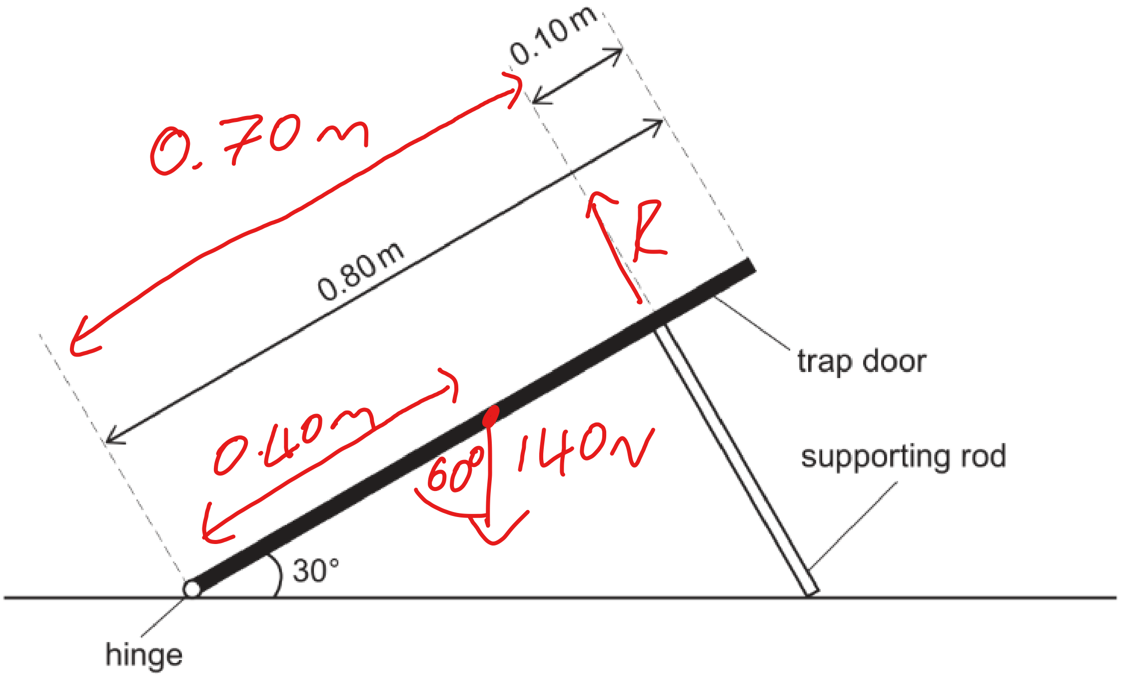
F $\frac{16}{17}$

$$\frac{960}{960+120+80} = \frac{960}{1160} = \frac{96}{116} = \frac{48}{58} = \frac{24}{29}$$

NSAA 2019, Q80

→ W = 140N

A uniform square trap door of side 0.80 m and mass 14 kg has a smooth hinge at one edge and is held open at an angle of 30° to the horizontal. It is supported by a single rigid rod placed so that it meets the surface of the trap door at 90° at a distance 0.10 m from the top edge of the trap door, as shown.



What is the normal contact force exerted on the trap door by the rod?

(gravitational field strength = 10 N kg^{-1})

A 40 N

B 35√3 N

[✓ **C** 40√3 N]

D 80 N

E 80√3 N

F $280\frac{\sqrt{3}}{3}$ N

Take moments about hinge:

$$(140\sin 60)\times 0.40 = R\times 0.70$$

$$140\times\frac{\sqrt{3}}{2}\times 0.40 = R\times 0.70$$

$$R = \frac{70\times\sqrt{3}\times 0.40}{0.70}$$

$$= 100\times\sqrt{3}\times 0.40$$

$$= 40\sqrt{3}\ N$$

NSAA 2019, Q76

A car P of mass 1000 kg is travelling north at 30 m s^{-1} along a straight, horizontal road when it hits another car Q which is directly ahead of P and travelling in the same direction. Car Q has a mass of 500 kg and is travelling at 20 m s^{-1}.

The collision lasts for 0.20 s and immediately after the collision car Q is moving north at 30 m s^{-1}.

What is the speed of P immediately after the collision and what is the size of the average resultant force that acts on Q during the collision?

(Assume that no external forces act on the cars during the collision.)

	speed of P / m s^{-1}	*average force on* Q / N
A	20 ✗	25 000
B	20 ✗	50 000
C	20 ✗	100 000
D	20 ✗	125 000
[✓ **E**]	25 ✓	25 000 ✓
F	25 ✓	50 000 ✗
G	25 ✓	100 000 ✗
H	25 ✓	125 000 ✗

Initial momentum:

$(1000 \times 30) + (500 \times 20)$

$= 30\ 000 + 10\ 000$

$= 40\ 000$ kgm/s

Final momentum:

$40\ 000 = 1000v + (500 \times 30)$

$40\ 000 = 1000v + 15\ 000$

$1000v = 25000$

$v = 25$ m/s

$$F = \frac{m\Delta v}{\Delta t} = \frac{1000 \times 5}{0.20}$$

$$= 5000 \times 5$$

$$= 25\ 000 \text{ N}$$

NSAA 2019, Q84

An astronaut on the Moon throws a ball vertically upwards. The ball has a mass of 2.0 g and is thrown upwards at 80 m s^{-1}.

What is the maximum height gained by the ball?

(gravitational field strength close to the Moon's surface = 1.6 N kg^{-1})

A 25 m

B 50 m

C 320 m

[✓ **D** 2000 m]

E 3200 m

F 4000 m

s – s
u – 80
v – 0
a – -1.6
t – X

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

$$0 = 80^2 - (3.2 \times s)$$

$$3.2s = 6400$$

$$s = \frac{6400}{3.2} = 2000m$$