Worked Solutions for ENGAA Papers by Topic

Section 1

Topic: Kinematics

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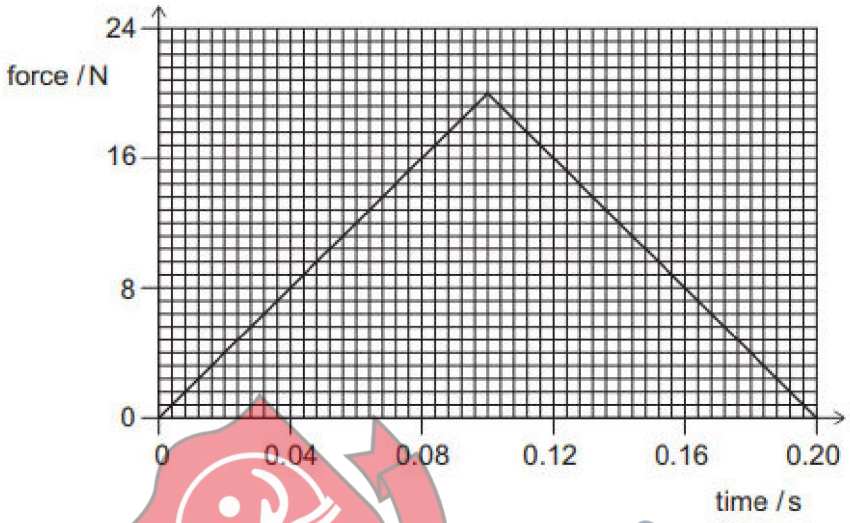
ENGAA S1 2020 - Question 37

37 An object of mass 2.5 kg is at rest at time = 0 s. A resultant force acts on the object in a constant direction.

The magnitude of the resultant force acting on the object varies with time as shown by the graph.



What is the kinetic energy of the object at time = 0.20 s?

A 0 J

B 0.80 J

C 1.0 J

D 1.6 J

E 2.0 J

F 3.2 J

G 6.4 J

ENGAA S1 2020 - Question 37 - Worked Solution

$$F = \frac{20.0}{2} = 10N$$

$$\mathrm{F} = \mathrm{m}\frac{v - n}{\mathrm{t}}$$

$$\mathrm{F}\Delta\mathrm{t} = \mathrm{mv} - \mathrm{m}(0)$$

$$v = \frac{F\Delta t}{m} = \frac{10N \times 0.25}{2.5kg} = 0.8ms^{-1}$$

$$\mathrm{T} = \frac{1}{2}\mathrm{mv}^2$$

$$T = \frac{1}{2} \times 2.5 \times (0.8)^2$$

$$\mathrm{T} = 0.8\mathrm{J}$$

Answer is B

ENGAA S1 2019 - Question 24

24 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

ENGAA S1 2019 - Question 24 - Worked Solution

Cons. of momentum

$$30 \times 1000 + 20 \times 500 = 1000 \times v + 30 \times 500$$

$$v = 25 ms^{-1}$$

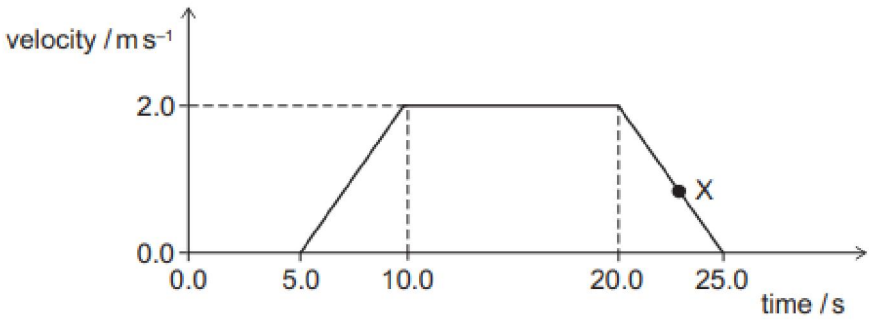
Impulse on Q, via Newton's 2nd Law:

$$F = m\frac{v-u}{\Delta t} \rightarrow F = 500\frac{30-20}{0.2} = 25 \times 10^3 N$$

Answer is E

ENGAA S1 2019 - Question 40

40 The velocity–time graph is for an 80 kg person in a lift that is moving vertically upwards.



What is the magnitude of the contact force between the person and the lift floor at the time corresponding to X?

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

A 640 N

B 768 N

C 800 N

D 832 N

E 960 N

ENGAA S1 2019 - Question 40 - Worked Solution

$$a = \frac{-2ms^{-1}}{5s} = 0.4ms^{-2}$$

$$\mathrm{F} = \mathrm{mg} + \mathrm{ma} = 80 \times 10 - 0.4 \times 80$$

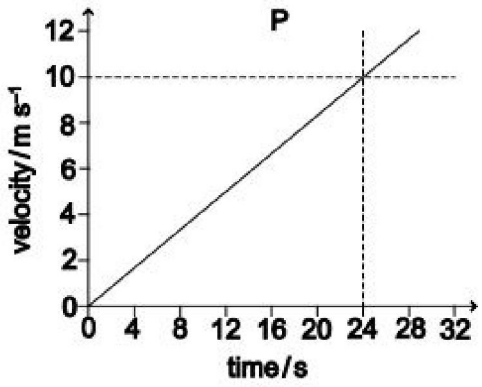
$$\mathrm{F} = 80(10 - 0.4)$$

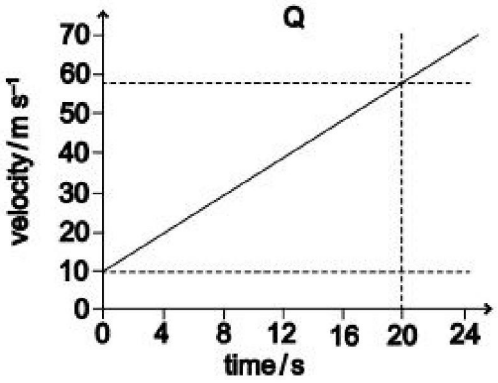
$$\mathrm{F} = 768\mathrm{N}$$

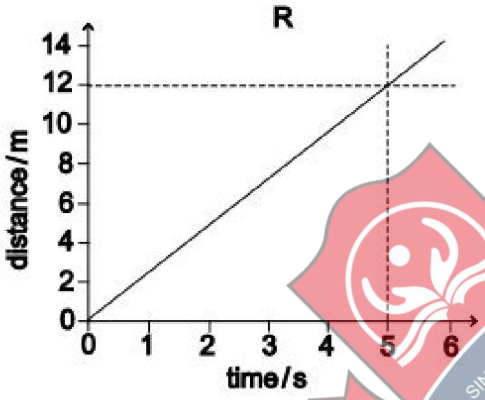
Answer is B

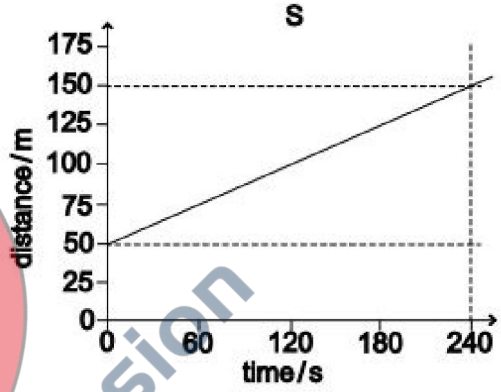
ENGAA Specimen S1 - Question 16

16 The diagrams below show either velocity-time or distance-time graphs for four different objects, P, Q, R and S.









Which graph(s) show an object accelerating at 2.4 $m s^{-2}$?

A P only

B Q only

C R only

D S only

E P and Q only

F Q and R only

G P and S only

ENGAA Specimen S1 - Question 16 - Worked Solution

$$a = \frac{\Delta v}{\Delta t}$$

Therefore acceleration is the gradient on a velocity-time graph.

$$P: a = \frac{10-0}{24} \neq 2.4ms^{-2}$$
$$Q: a = \frac{58-10}{20} = 2.4ms^{-2}$$

R & S give distance time graph and so the gradient represents velocity. Since the graphs are straight and gradient is constant, velocity is constant and there is no acceleration.
Q only

Answer is B

ENGAA Specimen S1 - Question 30

30 A certain planet has no atmosphere. The planet has a gravitational field strength at its surface of g_p N kg^{-1}; this value is considered constant for this question. A rock is projected vertically upwards from the surface of the planet at an initial speed of 20 m s^{-1}. The rock reaches a maximum height h metres.

Which option shows a possible correct pair of values for g_p and h?

(Consider only gravitational forces.)

A $g_p = 5.0$; $h = 4.0$

B $g_p = 5.0$; $h = 40$

C $g_p = 10$; $h = 2.0$

D $g_p = 20$; $h = 1.0$

E $g_p = 20$; $h = 20$

ENGAA Specimen S1 - Question 30 - Worked Solution

If all kinetic energy is converted to GPE as no air resistance:

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

$$v^2 = 2gh$$

$v = 20 ms^{-1}$ (initial speed)

$$h = \frac{200}{g}, g = \frac{200}{h}$$

Answer is B

ENGAA Specimen S1 - Question 34

34 The track for a tram is straight and horizontal. A tram is travelling along the track at a velocity of $12.0\,m\,s^{-1}$ when the brakes are applied. Because of this, the tram decelerates to rest at a constant rate of $1.50\,m\,s^{-2}$.

What is the distance travelled by the tram over the total time for which it is decelerating?

A 18.0 m

B 48.0 m

C 96.0 m

D 108 m

E 216 m

ENGAA Specimen S1 - Question 34 - Worked Solution

$$v^2 = u^2 + 2as$$
$$v = 0$$
$$u = 12.0$$
$$a = -1.50$$
$$s = \frac{v^2 - u^2}{2a}$$
$$= \frac{-12.0^2}{-2 \times 1.50}$$
$$= \frac{144}{3}$$
$$= 48.0\text{m}$$

Answer is B

ENGAA S1 2018 - Question 30

30 An aircraft moves from rest with uniform acceleration along a horizontal runway. After travelling 1600 m it reaches a speed of 80 m s^{-1}.

What is the acceleration of the aircraft?

A 0.025 m s^{-2}

B 0.050 m s^{-2}

C 0.10 m s^{-2}

D 0.50 m s^{-2}

E 2.0 m s^{-2}

F 4.0 m s^{-2}

G 10 m s^{-2}

H 20 m s^{-2}

ENGAA S1 2018 - Question 30 - Worked Solution

S = 1600

U = 0

V = 80

A = a

$$V^2 = U^2 + 2as$$

$$a = \frac{V^2 - U^2}{2s}$$

$$= \frac{80^2 - 0^2}{3200}$$

$$= 2\ ms^{-2}$$

Answer is E.

ENGAA S1 2018 - Question 54

54 An object is thrown vertically upwards from ground level with an initial velocity of $40\,m\,s^{-1}$.

2.0 seconds later another object is released from a height above the ground and falls vertically from rest.

Both of the objects hit the ground at the same time.

From what height above the ground was the second object released?

(gravitational field strength $g = 10\,N\,kg^{-1}$; air resistance can be ignored)

A 80 m

B 180 m

C 320 m

D 500 m

E 900 m

ENGAA S1 2018 - Question 54 - Worked Solution

From ①:

$$S = ut + \frac{1}{2}at^2 = 0$$

$$40t - \frac{1}{2}(10)t^2 = 0$$

$$40t - 5t^2 = 0$$

$$t = 0 \text{ or } t = 8$$

So ② hits ground in 6s

For second mass:

S = -h

U = 0

V =

A = -10

T = 6

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

$$-h = -\frac{10}{2}6^2$$

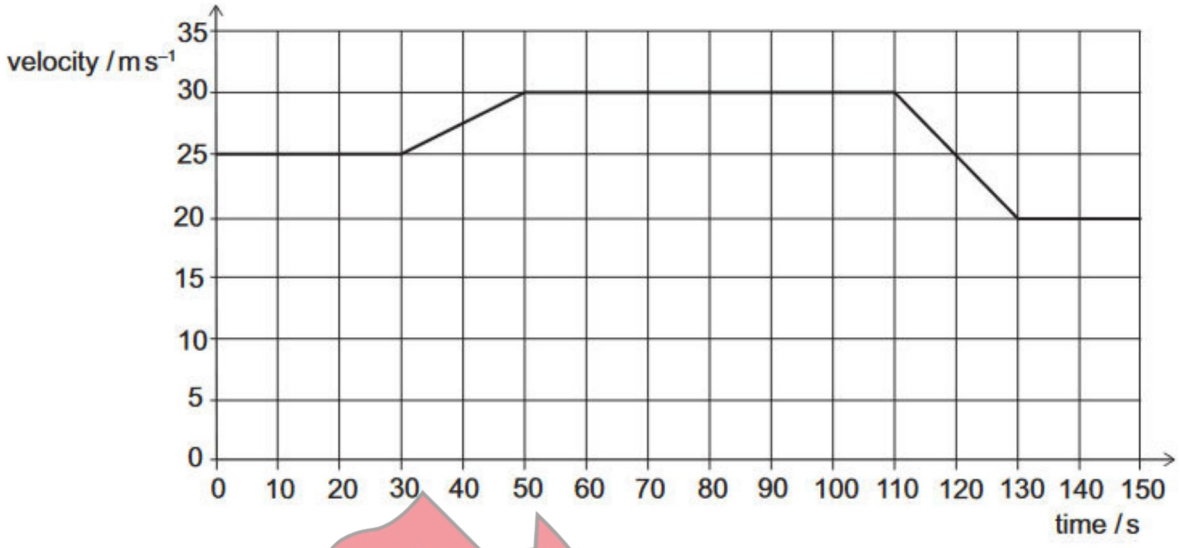
$$h = 180m$$

Answer is B

ENGAA S1 2017 - Question 2

2 A car is travelling along a horizontal road in a straight line.

The graph is a velocity–time graph for part of the car's journey.



During this part of the journey, what is the total distance that the car travels while it is decelerating?

A 400 m

B 500 m

C 550 m

D 600 m

E 750 m

F 1400 m

G 1800 m

H 1900 m

ENGAA 2017 - Question 2 - Worked Solution

Velocity time graph, so area = displacement

Gradient = acceleration

Deceleration = negative gradient

Area = area at trapezium

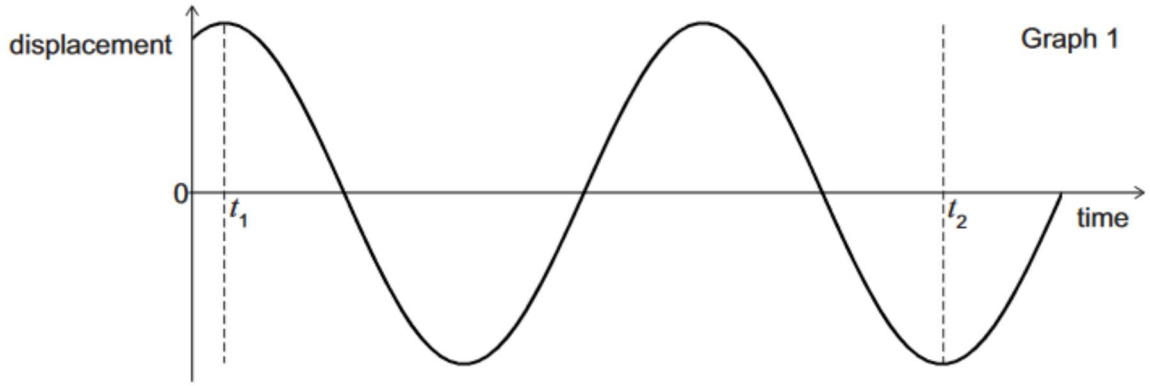
$$= \frac{1}{2} \times (30 + 20) \times 10$$

$= 500\text{m}$

Answer is B

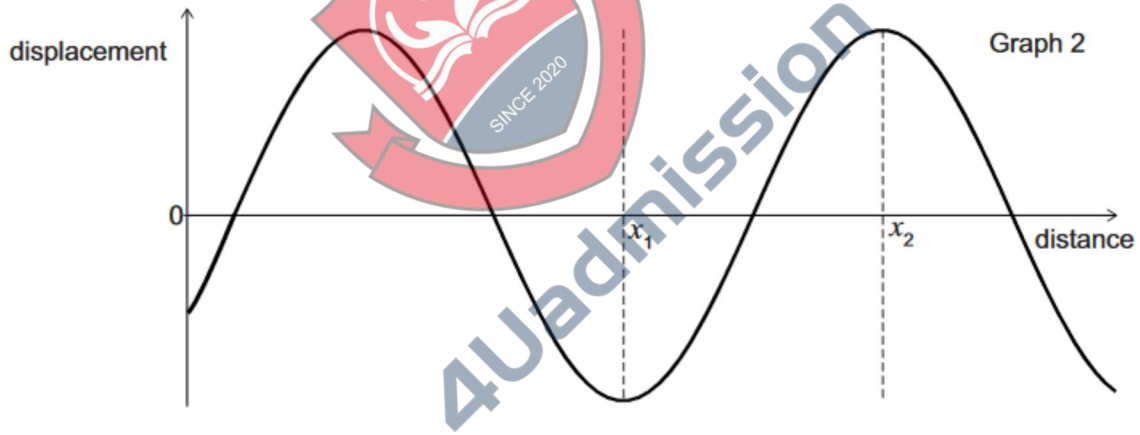
ENGAA S1 2017 - Question 18

18 Graph 1 shows how the displacement of one of the particles of a medium varies with time in seconds as a wave travels through the medium.



Graph 2 shows how the displacement varies with distance in metres at one time for the same wave.

Graph 2 shows how the displacement varies with distance in metres at one time for the same wave.



Which expression gives the speed in m s^{-1} of the wave?

A $\dfrac{4(x_2 - x_1)}{3(t_2 - t_1)}$

B $\dfrac{3(x_2 - x_1)}{2(t_2 - t_1)}$

C $\dfrac{2(x_2 - x_1)}{t_2 - t_1}$

D $\dfrac{8(x_2 - x_1)}{3(t_2 - t_1)}$

E $\dfrac{3(x_2 - x_1)}{t_2 - t_1}$

F $\dfrac{6(x_2 - x_1)}{t_2 - t_1}$

ENGAA 2017 - Question 18 - Worked Solution

$$\frac{3T}{2} = (t_2 - t_1)$$

$$T = \frac{2(t_2 - t_1)}{3}$$

$$\frac{\lambda}{2} = x_2 - x_1$$

$$\lambda = 2(x_2 - x_1)$$

$$v = f\lambda$$

$$v = \frac{\lambda}{T}$$

$$V = \frac{3(x_2 - x_1)}{(t_2 - t_1)}$$

Answer is E

ENGAA S1 2017 - Question 38

38 A ball starts at a speed of $40.0\,m\,s^{-1}$. The ball is subject to a constant deceleration of $14.4\,m\,s^{-2}$ as it travels a distance of 20.0 m in a straight line.

What is the final speed of the ball?

A $16.0\,m\,s^{-1}$

B $20.0\,m\,s^{-1}$

C $25.6\,m\,s^{-1}$

D $32.0\,m\,s^{-1}$

E $36.2\,m\,s^{-1}$

F $39.3\,m\,s^{-1}$

ENGAA S1 2017 - Question 38 - Worked Solution

s = 20

u = 40

v = v

A = - 14.4

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

$v = \sqrt{u^2 + 2as}$

$= \sqrt{(40)^2 - 2 \times 14.4 \times 20}$

$= \sqrt{1024}$

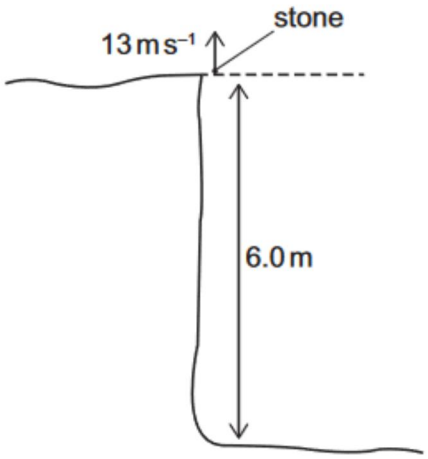
$= 32\,ms^{-1}$

Answer is D

ENGAA S1 2017 - Question 44

44 A stone is fired vertically upwards at a speed of $13\,m\,s^{-1}$ on a still day from the top of a 6.0 m high cliff. It then falls down and lands at the bottom of the cliff.

[diagram not to scale]



From when the stone passes the top of the cliff on the way down, how long does it take to reach the ground at the bottom of the cliff?

(air resistance can be ignored; gravitational field strength = $10\,N\,kg^{-1}$)

A 0.40 s

B $\frac{6.0}{6.5}$ s

C 0.60 s

D $\sqrt{1.2}$ s

E 1.3 s

F 2.0 s

G 2.5 s

H 3.0 s

ENGAA S1 2017 - Question 44 - Worked Solution

Projectile motion is symmetric by conservation at energy, so will pass cliff with u = $-13ms^{-1}$

S = -6

u = -13

A = -10

T = t

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

$$-6 = -13t - \frac{10}{2}t^2$$

$$5t^2 + 13t + 6 = 0$$

$$(5t - 2)(t + 3) = 0$$

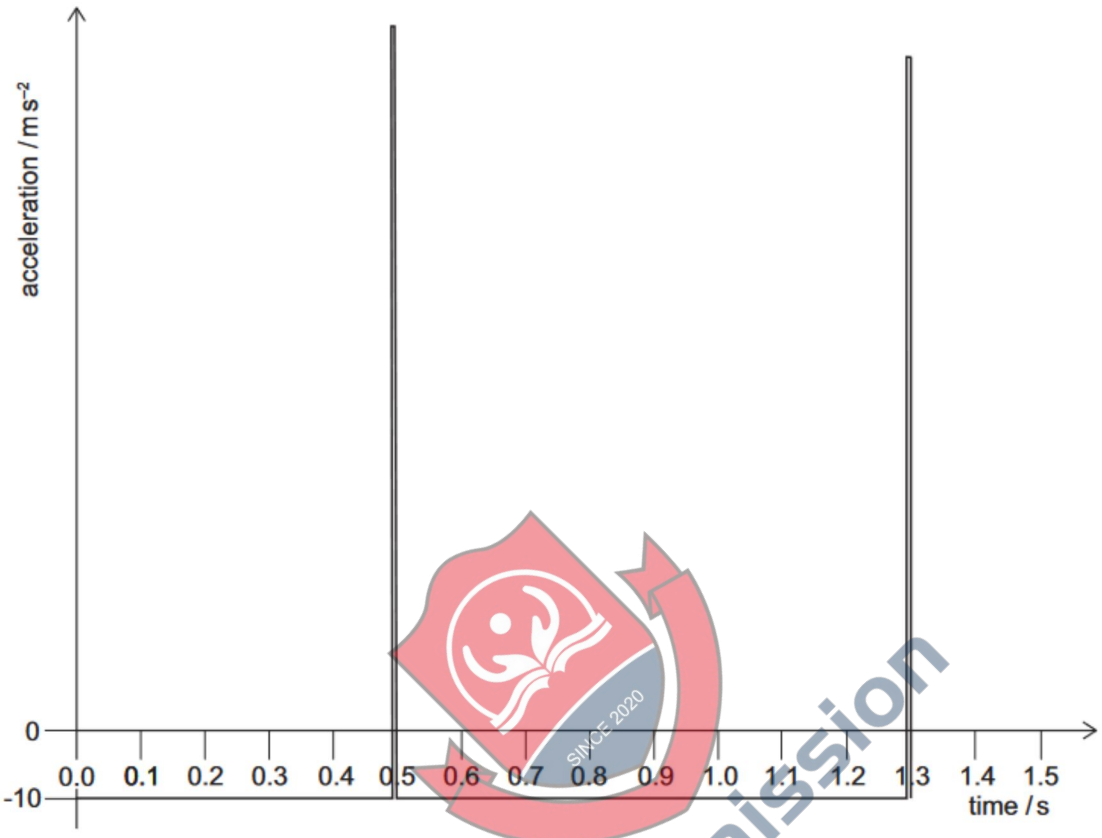
$$t = 0.4 \text{ or } -3 \qquad (t > 0)$$

$$t = 0.4s$$

Answer is A

ENGAA S1 2017 - Question 54

54 The acceleration versus time graph is for a ball dropped from rest, falling vertically and bouncing on the ground.



The time of contact with the ground can be ignored.

What is the speed of the ball immediately **after** hitting the ground for the first time, and what is the maximum height reached by the ball after the first bounce?

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

	speed / m s^{-1}	*height* / m
A	4.00	0.80
B	4.00	1.25
C	5.00	0.80
D	5.00	1.25
E	8.00	3.20

ENGAA S1 2017 - Question 54 - Worked Solution

① Reaches max height at:

$$t = \frac{1.3 - 0.5}{2} = 0.4$$

At max height v = 0

S = ?
U = u
V = 0
A = -10
T = 0.4

$$v = utat$$
$$0 = u - 10 \times 0.4$$
$$u = 4ms^{-1}$$

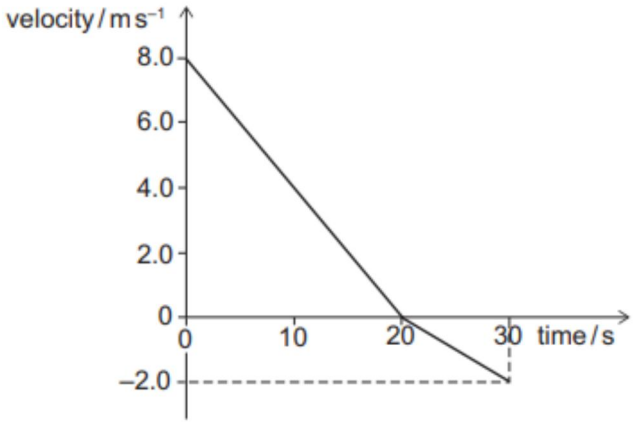
②

S = s
U =
V = 0
A = -10
T = 0.4

$$S = vt - \frac{1}{2}at^2$$
$$= 0 - \left(\frac{1}{2}\right)(-10)(0.4)^2$$
$$= 0.8m$$

ENGAA S1 2016 - Question 22

22 The diagram shows the velocity-time graph for an object travelling in a straight line over a period of 30 s.



What total distance did the object travel in the 30 s, how far from its starting position was it at the end of the 30 s, and what was its average speed over the 30 s?

	total distance travelled / m	*distance from starting position / m*	*average speed / m s⁻¹*
A	90	70	3.0
B	90	70	5.0
C	90	90	3.0
D	90	90	5.0
E	180	140	5.0
F	180	140	6.0
G	180	180	5.0
H	180	180	6.0

ENGAA S1 2016 - Question 22 - Worked Solution

Distance = area between v - t curve and t - axis regardless of above or below t - axis

$$\text{distance} = \frac{1}{2} \times 8 \times 20 + \frac{1}{2} \times 2 \times 10$$

$$\text{distance} = 80 + 10 = 90\text{m}$$

$$\text{Average speed} = \text{distance} \div \text{time} = \frac{90}{30} = 3\text{ms}^{-1}$$

Distance from starting position = area between v - t curve and t - axis taking area under the t - axis as - ve

$$= \frac{1}{2} \times 8 \times 20 - \frac{1}{2} \times 2 \times 10$$
$$= 70\text{m}$$

Answer is A

ENGAA S1 2016 - Question 44

44 An object is fired vertically upwards from the ground at time $t = 0$ s in still air at a speed of $8.0\,m\,s^{-1}$.

On the way up, what is the height of the object above the ground when it has a speed of $2.0\,m\,s^{-1}$, and at what time does it reach this height on the way down?

(The gravitational field strength g is $10\,N\,kg^{-1}$. Air resistance can be ignored.)

	height / m	*time* / s
A	2.4	0.60
B	2.4	0.64
C	2.4	1.0
D	2.4	2.0
E	3.0	0.60
F	3.0	0.64
G	3.0	1.0
H	3.0	2.0

ENGAA S1 2016 - Question 44 - Worked Solution

Use suvats Take as upward as +ve

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

$$a = -10ms^{-2}$$

$$u = 8.0ms^{-1}$$

$$2^2 = 8^2 - 2 \times 10 \times h$$

$$20h = 8^2 - 2^2 = 60$$

$$h = 3.0m$$

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

$$3 = 8t - 5t^2$$

$$5t^2 - 8t + 3 = 0$$

$$t^2 - \frac{8}{5}t + \frac{3}{5} = 0$$

$$\left(t - \frac{4}{5}\right)^2 - \left(\frac{4}{5}\right)^2 + \frac{3}{5} = 0$$

$$\left(t - \frac{4}{5}\right)^2 = \frac{16}{25} - \frac{3}{5}$$

$$\left(t-\frac{4}{5}\right)^2=\frac{1}{25}$$

$$t-\frac{4}{5}=\pm\frac{1}{5}$$

$$t=1s, \qquad t=\frac{3}{5}s \quad \textit{The later time will be the way down}$$

Answer is G