IGCSE Cambridge Topical Past Papers

PHYSICS 9-1

0972 Paper 4

2020 — 2025

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1 - (0972/41_Summer_2020_Q1)

An aeroplane of mass 2.5×10^5 kg lands with a speed of 62 m/s, on a horizontal runway at time t = 0. The aeroplane decelerates uniformly as it travels along the runway in a straight line until it reaches a speed of 6.0 m/s at t = 35 s.

(a) Calculate:

(i) the deceleration of the aeroplane in the 35 s after it lands

deceleration = ... [2]

(ii) the resultant force acting on the aeroplane as it decelerates

force = ... [2]

(iii) the momentum of the aeroplane when its speed is 6.0 m/s.

momentum = ... [2]

(b) At t = 35 s, the aeroplane stops decelerating and moves along the runway at a constant speed of 6.0 m/s for a further 15 s.

On Fig. 1.1, sketch the shape of the graph for the distance travelled by the aeroplane along the runway between t = 0 and t = 50 s. You are **not** required to calculate distance values.

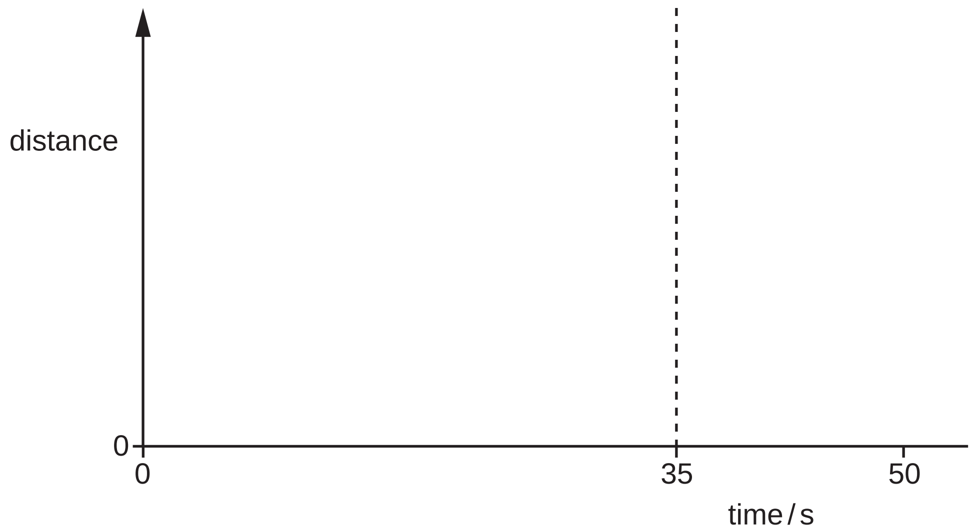


Fig. 1.1

[3]

(c) As the aeroplane decelerates, its kinetic energy decreases.

Suggest what happens to this energy.

.... [1]

[Total: 10]

2 - (0972/41_Summer_2020_Q2)

Fig. 2.1 is the extension–load graph for a light spring S.

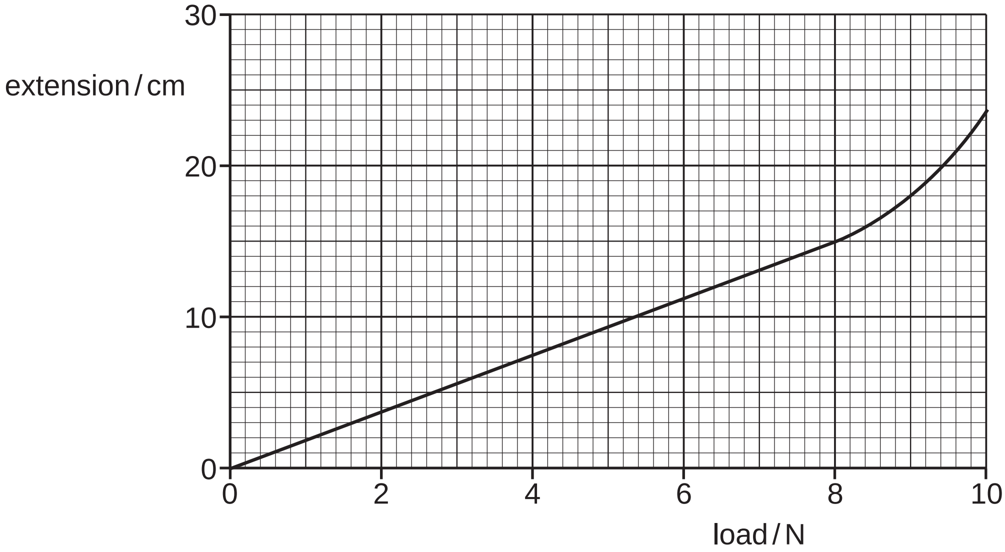


Fig. 2.1

(a) State the range of loads for which S obeys Hooke's law.

from .... to .... [1]

(b) Using information from Fig. 2.1, determine the spring constant k of spring S.

k = ... [2]

(c) A second spring, identical to spring S, is attached to spring S. The two springs are attached to a rod, as shown in Fig. 2.2. A load of 4.0 N is suspended from the bottom of spring S. The arrangement is in equilibrium.

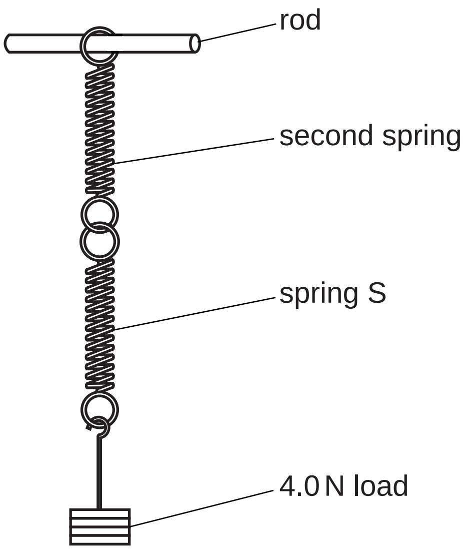


Fig. 2.2

(i) State the name of the form of energy stored in the two springs when they are stretched.

.... [1]

(ii) Determine the extension of the arrangement in Fig. 2.2.

extension = ... cm [1]

(iii) The load is carefully increased to 6.0 N in total.

Calculate the distance moved by the load to the new equilibrium position as the load increases from 4.0 N to 6.0 N.

distance moved = ... [1]

[Total: 6]

3 - (0972/42_Summer_2020_Q1)

Fig. 1.1 shows the speed–time graph of a person on a journey.

On the journey, he walks and then waits for a bus. He then travels by bus. He gets off the bus and waits for two minutes. He then walks again. His journey takes 74 minutes.

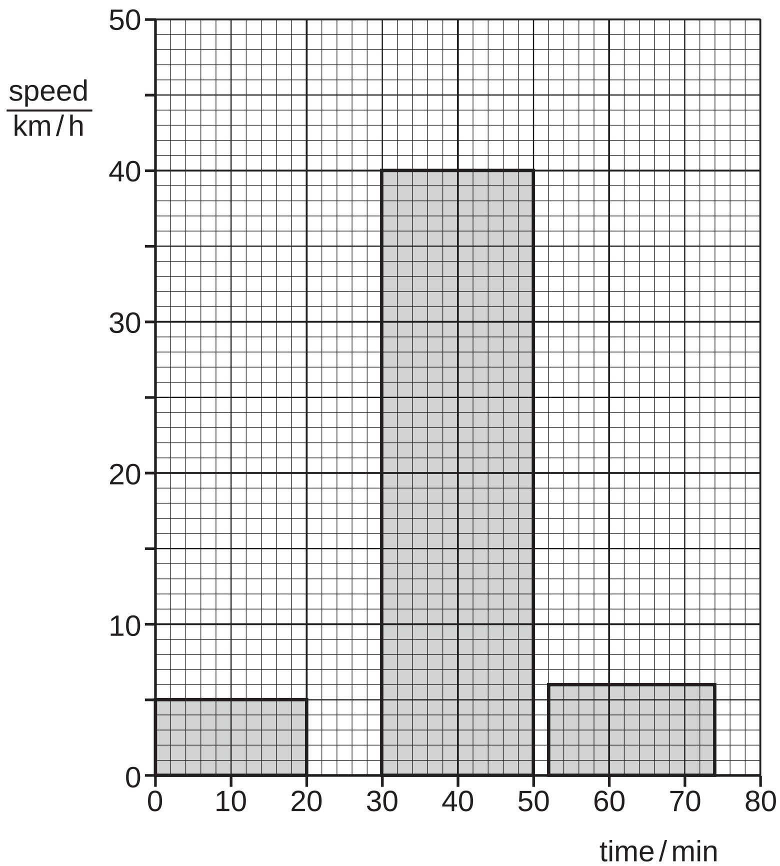


Fig. 1.1

(a) For the whole journey calculate:

(i) the distance travelled

distance = ... [3]

(ii) the average speed.

average speed = ... [2]

(b) State and explain which feature of a speed–time graph shows acceleration.

.... [2]

(c) State and explain the acceleration of the person at time = 40 minutes.

.... [2]

[Total: 9]

4 - (0972/42_Summer_2020_Q2)

Fig. 2.1 shows a train.

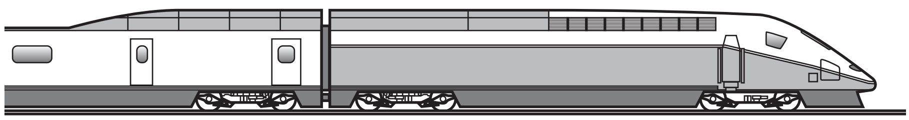


Fig. 2.1

The total mass of the train and its passengers is 750 000 kg. The train is travelling at a speed of 84 m/s. The driver applies the brakes and the train takes 80 s to slow down to a speed of 42 m/s.

(a) Calculate the impulse applied to the train as it slows down.

impulse = ... [3]

(b) Calculate the average resultant force applied to the train as it slows down.

force = ... [2]

(c) Suggest how the shape of the train helps it to travel at high speeds.

.... [1]

(d) The train took 80 s to reduce its speed from 84 m/s to 42 m/s. Explain why, with the same braking force, the train takes more than 80 s to reduce its speed from 42 m/s to zero.

.... [1]

(e) On a wet day, the train travels a greater distance before it stops along the same track. The train has the same speed of 84 m/s before the brakes are applied.

Suggest a reason for this.

.... [1]

[Total: 8]

5 - (0972/41_Winter_2020_Q1)

Fig. 1.1 shows an ice-hockey player moving on ice. He is preparing to hit the solid disc called a puck.

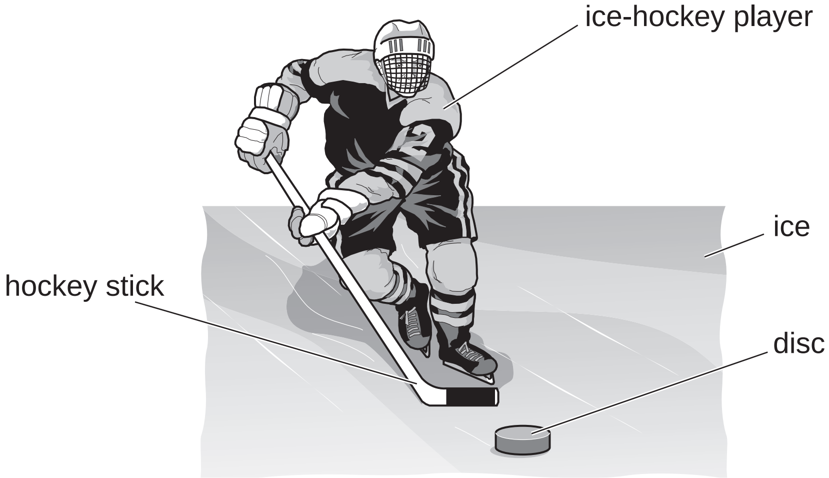


Fig. 1.1

The disc of mass 0.16 kg is moving horizontally across the surface of the ice at a speed of 15 m/s.

(a) Calculate the magnitude of the momentum of the disc.

magnitude of momentum = ... [2]

(b) The hockey player strikes the disc with his hockey stick and the momentum of the disc changes. The disc gains momentum of 3.0 kg m/s at 45° to the original direction of travel of the disc, as shown in Fig. 1.2.

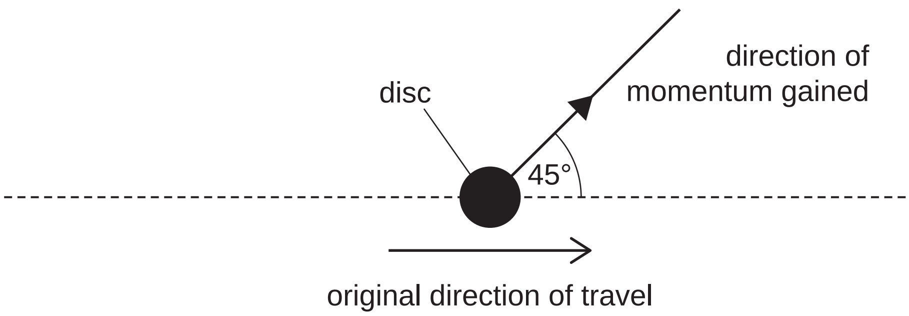


Fig. 1.2 (view from above)

(i) State the magnitude of the impulse exerted on the disc and the direction, in degrees, of the impulse relative to the original direction of travel.

magnitude of impulse = ...

direction of impulse: .... ° to original direction [1]

(ii) Determine the magnitude of the new momentum of the disc and its new direction relative to the original direction of travel by drawing a scale diagram.

magnitude of new momentum = ...

direction of new momentum: .... ° to original direction [4]

[Total: 7]

6 - (0972/41_Winter_2020_Q2)

A vertical tube contains a liquid. A metal ball is held at rest by a thread just below the surface of the liquid, as shown in Fig. 2.1.

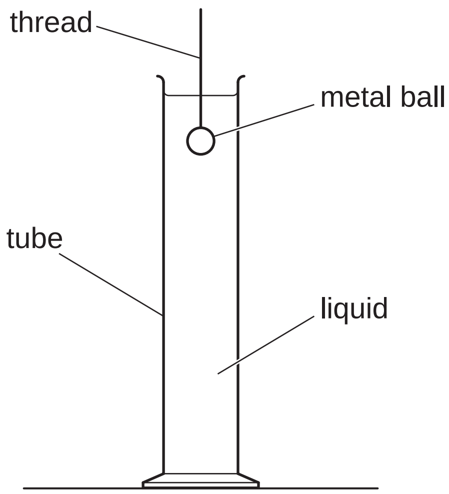


Fig. 2.1 (not to scale)

The diameter of the tube is much greater than the diameter of the ball. The ball is released and it accelerates downwards uniformly for a short period of time.

(a) Describe what happens to the velocity of the ball in the short period of time as it accelerates downwards uniformly.

.... [2]

(b) The ball reaches terminal velocity.

Describe and explain the motion of the ball from when it is released until it reaches terminal velocity.

.... [3]

(c) The metal ball has a mass of 2.1 g. It falls a distance of 0.80 m between being released and reaching the bottom of the tube.

(i) Calculate the gravitational potential energy transferred from the ball as it falls.

gravitational potential energy transferred = ... [2]

(ii) When the ball reaches the bottom of the tube, it has a speed of 1.2 m/s. Calculate the kinetic energy of the ball at the bottom of the tube.

kinetic energy = ... [3]

(iii) Explain why the value calculated in **(c)(i)** is different from that calculated in **(c)(ii)**.

.... [1]

[Total: 11]

7 - (0972/41_Winter_2020_Q3)

A U-shaped tube of constant cross-sectional area contains water of density 1000 kg / m^3. Both sides of the U-tube are open to the atmosphere.

Fig. 3.1 shows that the water levels in the two sides of the tube are equal.

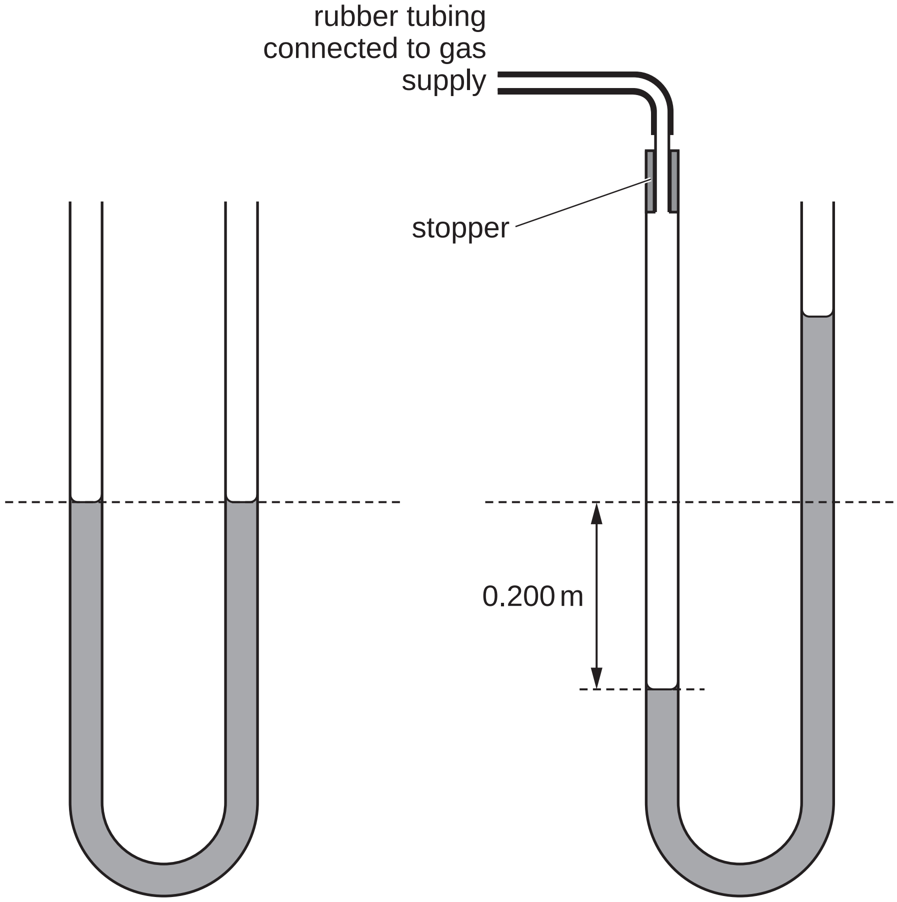


Fig. 3.1 **Fig. 3.2**

The atmospheric pressure is 1.00×10^5 Pa.

The left-hand side of the tube is now connected to a gas supply using a length of rubber tubing. This causes the level of the water in the left-hand side of the tube to drop by 0.200 m, as shown in Fig. 3.2.

(a) Calculate the pressure of the gas supply. Give your answer to 3 significant figures.

pressure = ... [3]

(b) Fig. 3.3 shows that the gas supply is now connected to a cylinder that contains a piston.

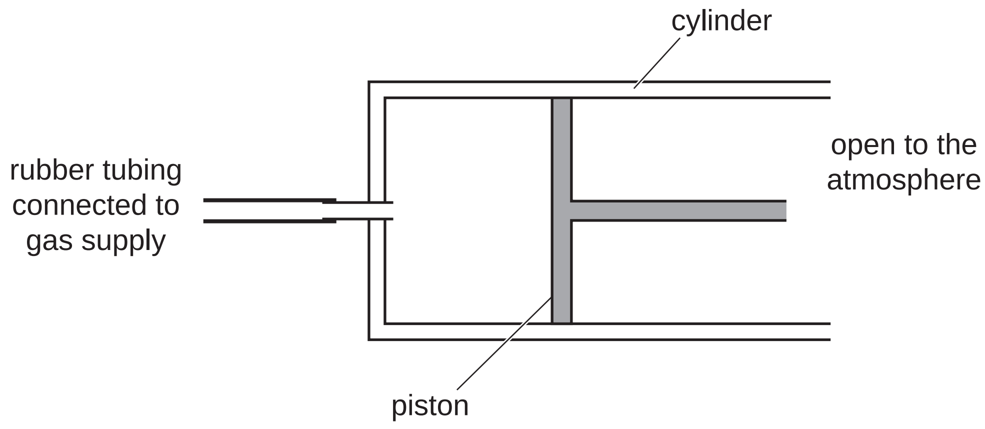


Fig. 3.3

The pressure of the gas moves the piston to the right.

(i) The area of the piston in contact with the gas is 0.025 m^2.

Calculate the resultant force on the piston.

resultant force = ... [2]

(ii) The pressure of the gas causes the piston to move a distance of 0.50 m to the right.

Calculate the work done by the gas from the supply on the piston.

work done = ... [2]

[Total: 7]

8 - (0972/41_Summer_2021_Q1)

A skydiver of mass 76 kg is falling vertically in still air. At time $t = 0$, the skydiver opens his parachute.

Fig. 1.1 is the speed–time graph for the skydiver from $t = 0$.

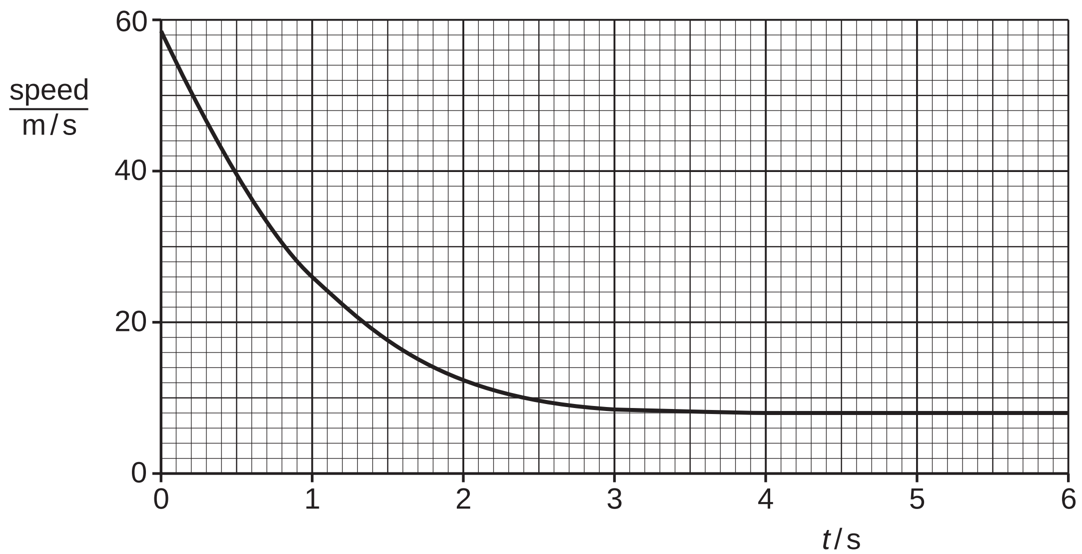


Fig. 1.1

(a) Using Fig. 1.1, determine:

(i) the deceleration of the skydiver immediately after the parachute opens

deceleration = ... [2]

(ii) the force due to air resistance acting on the skydiver immediately after the parachute opens.

force = ... [3]

(b) Explain, in terms of the forces acting on the skydiver, his motion between t = 0 and t = 6.0 s.

.... [3]

(c) Explain why opening the parachute cannot reduce the speed of the skydiver to zero.

.... [2]

[Total: 10]

9 - (0972/41_Summer_2021_Q2)

Fig. 2.1 shows a wooden trolley of mass 1.2 kg at rest on the rough surface of a bench.

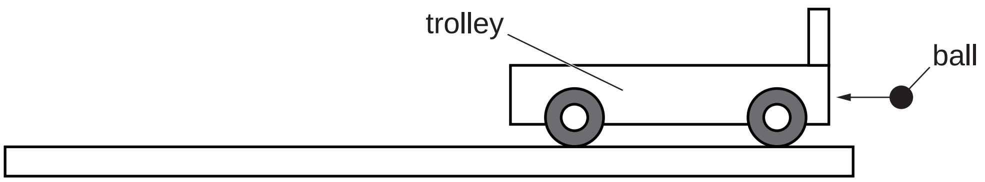


Fig. 2.1

A ball of mass 0.52 g travels horizontally towards the trolley. The ball embeds itself in the wood of the trolley. The trolley moves with an initial speed of 0.065 m / s.

(a) Calculate:

(i) the impulse exerted on the trolley

impulse = ... [2]

(ii) the speed of the ball as it hits the trolley.

speed = ... [2]

(b) As the trolley moves across the rough surface, it slows down and stops.

Explain, in terms of the work done, the energy change that takes place as the trolley slows down.

.... [3]

[Total: 7]

1 - (0972/41_Summer_2020_Q1)

(a)(i)	(a =) $(v – u) / t$ OR (62 – 6.0) / 35 OR 56 / 35	**C1**
	1.6 m / s^2	**A1**
(a)(ii)	(F =) ma OR $\Delta p / \Delta t$ OR $2.5 \times 10^5 \times 1.6$ OR $(62 \times 2.5 \times 10^5 – 6.0 \times 2.5 \times 10^5) / 35$	**C1**
	4.0×10^5 N	**A1**
(a)(iii)	(p =) mv OR $2.5 \times 10^5 \times 6.0$	**C1**
	1.5×10^6 kg m / s	**A1**
(b)	curve of decreasing gradient from (0,0) to a point along dashed line	**B1**
	straight line of positive gradient after $t = 35$ s	**B1**
	gradient not zero at $t = 35$ s OR no change of gradient (at $t = 35$ s)	**B1**
(c)	thermal energy AND in something specific (e.g. brakes / air / tyres) OR kinetic energy of air	**B1**

2 - (0972/41_Summer_2020_Q2)

(a)	0 (N) AND 8.0 N	**B1**
(b)	(k =) F / x OR 8.0 / 0.15	**C1**
	53 N / m OR 0.53 N / cm	**A1**
(c)(i)	elastic potential (energy)	**B1**
(c)(ii)	15 cm	**B1**
(c)(iii)	7.5 cm OR 2(c)(ii) / 2	**B1**

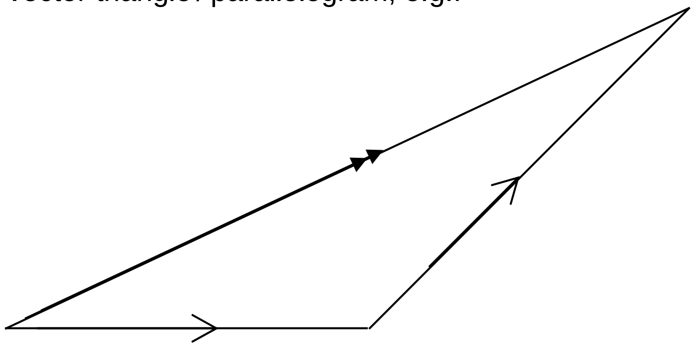
3 - (0972/42_Summer_2020_Q1)

(a)(i)	s= vt in any form OR (s =) vt OR relates distance to area (under graph)	**C1**
	any **one** of: $5 \times 20 / 60$ OR $40 \times 20 / 60$ OR $6 \times 22 / 60$	**C1**
	(s = 1.667 + 13.333 + 2.2 =) 17 km	**A1**
(a)(ii)	average speed = candidate's (i) / time	**C1**
	(average speed = $17 \times 60 / 74$ =) 14 km / h	**A1**
(b)	gradient	**B1**
	(gradient =) change of speed / time	**B1**
(c)	0	**B1**
	(constant) gradient = 0 OR speed constant	**B1**

4 - (0972/42_Summer_2020_Q2)

(a)	impulse OR $\Delta p = m(v - u)$ in any form	**C1**
	(impulse =) 750 000 (84 – 42)	**C1**
	(impulse =) 3.2×10^7 N s or m kg / s	**A1**
(b)	Ft = impulse OR Δp in any form OR (F =) (impulse OR Δp) / t	**C1**
	(F = $3.2 \times 10^7 / 80$ =) 3.9×10^5 N	**A1**
(c)	reduces drag / air resistance (experienced by the train) / more streamlined	**B1**
(d)	less drag / air resistance (at slower speeds)	**B1**
(e)	(maximum) friction (force) between rails and train reduced / train may slide	**B1**

5 - (0972/41_Winter_2020_Q1)

(a)	(p =) mv (in any form) **or** 0.16×15	**C1**
	2.4 kg m / s	**A1**
(b)(i)	3.0 N s **and** at 45° to the original direction	**B1**
(b)(ii)	vector triangle / parallelogram, e.g.: 	**B1**
	scale indicated **or** correct triangle / parallelogram	**B1**
	4.8 kg m / s $\leqslant$ magnitude $\leqslant$ 5.2 kg m / s	**B1**
	22° (to original direction) $\leqslant$ direction $\leqslant$ 28°(to original direction)	**B1**

6 - (0972/41_Winter_2020_Q2)

(a)	it / velocity / speed changes / increases (with time)	**C1**
	it / velocity / speed <u>increases</u> at constant rate / steadily	**A1**
(b)	any **three** from: • (initial) acceleration caused by weight / force of gravity • acceleration decreases • drag / resistance force increases (with speed) • (finally / at terminal velocity) no acceleration / constant speed • (finally / at terminal velocity) no resultant force	**B3**
(c)(i)	(GPE =) $mg\,(\Delta)\,h$ (in any form) **or** $0.0021 \times 10 \times 0.80$ **or** $2.1 \times 10 \times 0.80$ **or** 17 (J)	**C1**
	0.017 J	**A1**
(c)(ii)	(KE =) $\frac{1}{2}mv^2$ (in any form)	**C1**
	$\frac{1}{2} \times 0.0021 \times 1.2^2$ **or** $\frac{1}{2} \times 2.1 \times 1.2^2$ **or** 1.5 (J)	**C1**
	1.5×10^{-3} J	**A1**
(c)(iii)	(work done against) friction / drag / resistance **or** thermal energy generated **or** (displaced) liquid gains gravitational potential energy	**B1**

7 - (0972/41_Winter_2020_Q3)

(a)	(p_{liq} =) $h\rho g$ (in any form) **or** 0.400 × 1000 × 10 **or** 2000 **or** 4000 **or** 1.02 × 10^5 (Pa)	**C1**
	(p =) p_{atm} + $h\rho g$ (in any form) **or** 1.00 × 10^5 + 0.400 × 1000 × 10 **or** 4000 **or** 1.02 × 10^5 (Pa)	**C1**
	1.04 × 10^5 Pa	**A1**
(b)(i)	(F =) pA (in any form) **or** 4000 × 0.025	**C1**
	100 N	**A1**
(b)(ii)	(W.D. =) $F \times x$ (in any form) **or** 1.04 × 10^5 × 0.025 × 0.50 **or** 4000 × 0.025 × 0.50 **or** 50 (J)	**C1**
	1300 J	**A1**

8 - (0972/41_Summer_2021_Q1)

(a)(i)	any value from 35 to 43 m / s^2	**A2**
	(a =) (v – u) / t in any form **or** gradient (of line) **or** (58 – 50) / 0.20 **or** equivalent values from the graph	**C1**
(a)(ii)	3800 N	**A3**
	(F =) ma in any form **or** Δp / Δt in any form **or** 76 × candidate's **1(a)(i)** **or** 760 seen	**C1**
	76 × candidate's **1(a)(i)** <u>evaluated</u> **or** 76 × (candidate's **1(a)(i)** + 10) **or** 76 × (candidate's **1(a)(i)**)+ 760	**C1**

(b)	(deceleration because) upward force greater than weight **or** upward resultant force	**B1**
	air resistance decreases (with decreasing speed / with time) **or** deceleration decreases **or** resultant (upward) force decreases	**B1**
	(until / finally) weight equals air resistance **or** forces balance **or** at terminal / constant velocity / speed	**B1**
(c)	at zero speed there is no air resistance	**B1**
	weight / downwards force is (still) acting **or** there is (now) a resultant force (downwards at zero speed)	**B1**
	OR forces balance at a speed greater than zero	**(B1)**
	speed cannot decrease / no deceleration once forces balance	**(B1)**

9 - (0972/41_Summer_2021_Q2)

(a)(i)	0.078 N s **or** 0.078 kg m / s	**A2**
	(I =) $m_t(\Delta)v_t$ in any form **or** 1.2×0.065	**C1**
(a)(ii)	150 m / s	**A2**
	$v_b = (m_t + v_t) / m_b$ in any form **or** initial momentum = final momentum **or** $1.2(0052) \times 0.065 / 0.00052$ **or** $0.078(0338) / 0.00052$	**C1**
(b)	<u>work done</u> against / due to / because of friction **or** kinetic energy (of trolley) used to <u>do work</u>	**B1**
	kinetic energy decreases (to zero)	**B1**
	thermal energy produced	**B1**