Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | Candidate Number

Time 1 hour 30 minutes

Paper reference **WPH11/01**

Physics

International Advanced Subsidiary/Advanced Level
UNIT 1: Mechanics and Materials

You must have:
Scientific calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- **Show all your working in calculations and include units where appropriate**.

Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*****), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.
- The list of data, formulae and relationships is printed at the end of this booklet.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- Good luck with your examination.

Turn over ▶

SECTION A

Answer ALL questions.

For questions 1-10, in Section A, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Which of the following is a scalar quantity?

☐ **A** weight

☐ **B** momentum

☐ **C** terminal velocity

☐ **D** kinetic energy

(Total for Question 1 = 1 mark)

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2 A cylinder of aluminium has a weight of 35.0 N and a volume of $1.32 \times 10^{-3}\,\text{m}^3$.

Which of the following calculations gives the density of aluminium in kg m^{-3}?

☐ **A** $\dfrac{9.81 \times 1.32 \times 10^{-3}}{35.0}$

☐ **B** $\dfrac{1.32 \times 10^{-3}}{35.0 \times 9.81}$

☐ **C** $\dfrac{35.0}{9.81 \times 1.32 \times 10^{-3}}$

☐ **D** $\dfrac{35.0 \times 9.81}{1.32 \times 10^{-3}}$

(Total for Question 2 = 1 mark)

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3 A van travels along a straight, horizontal road at a constant velocity.

Which of the following statements is correct?

☒ **A** The frictional force of the road on the tyres can be ignored.

☒ **B** The frictional force of the road on the tyres is equal to the resultant force on the van.

☒ **C** The frictional force of the road on the tyres is in the direction of motion of the van.

☒ **D** The frictional force of the road on the tyres is in the opposite direction to the motion of the van.

(Total for Question 3 = 1 mark)

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4 A hydroelectric power station has an efficiency of 32%. In one hour the useful energy output of the power station is 1.2×10^{13} J.

Which of the following expressions gives the total power input to the power station in watts?

☒ **A** $1.2 \times 10^{13} \times 0.32$

☒ **B** $\dfrac{1.2 \times 10^{13}}{0.32 \times 3600}$

☒ **C** $\dfrac{1.2 \times 10^{13} \times 0.32}{3600}$

☒ **D** $\dfrac{1.2 \times 10^{13}}{0.32}$

(Total for Question 4 = 1 mark)

5 A compressive force F is applied to an object made of a material with Young modulus E. The original length of the object in the direction of the force is x, and its cross-sectional area is A.

Which expression gives the length of the object after the force is applied?

☒ **A** $x - \frac{AE}{Fx}$

☒ **B** $x + \frac{Fx}{AE}$

☒ **C** $x + \frac{AE}{Fx}$

☒ **D** $x - \frac{Fx}{AE}$

(Total for Question 5 = 1 mark)

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6 A tractor pulls a trailer a distance s in time t. The useful power output of the tractor is P.

Which of the following equations gives the force F of the tractor on the trailer?

☒ **A** $F = Pts$

☒ **B** $F = \frac{Pt}{s}$

☒ **C** $F = \frac{Ps}{t}$

☒ **D** $F = \frac{st}{P}$

(Total for Question 6 = 1 mark)

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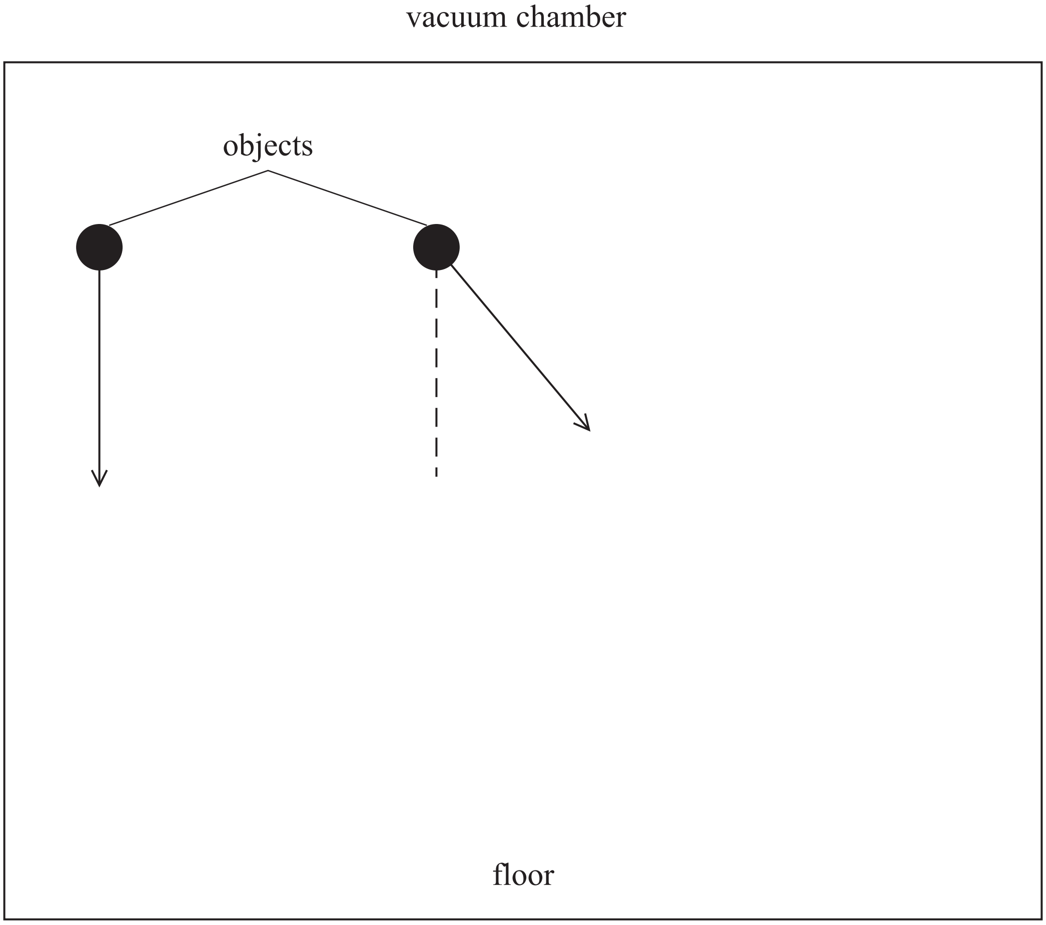
7 Two objects with the same initial speed fall from the same height in a vacuum chamber, as shown. The arrows in the diagram show initial directions of travel of the objects.



Which of the following quantities are **not** the same for both objects?

☒ **A** The accelerations of the objects during the fall.

☒ **B** The velocities of the objects as they reach the floor.

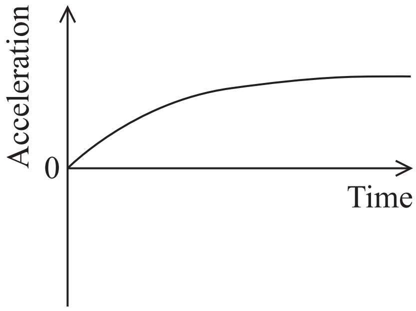
☒ **C** The increase in the speeds of the objects during the fall.

☒ **D** The kinetic energies of the objects as they reach the floor.

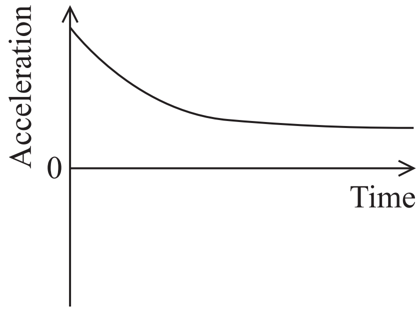
(Total for Question 7 = 1 mark)

8 A constant forward force acts on a car. The car accelerates along a straight road. After a while, the speed of the car reaches a constant value.

Which graph shows the variation of acceleration with time for the car?



A



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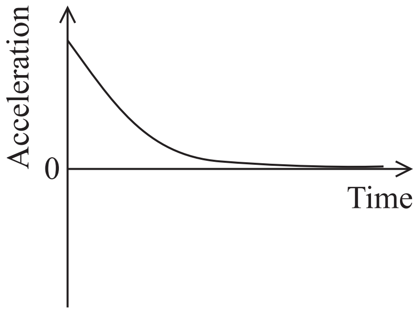

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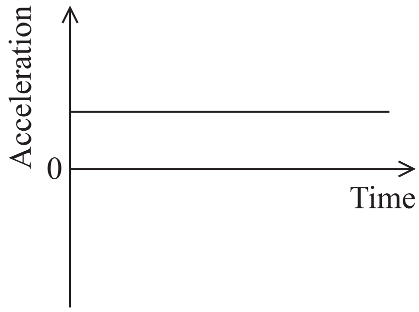


D

☒ **A**

☒ **B**

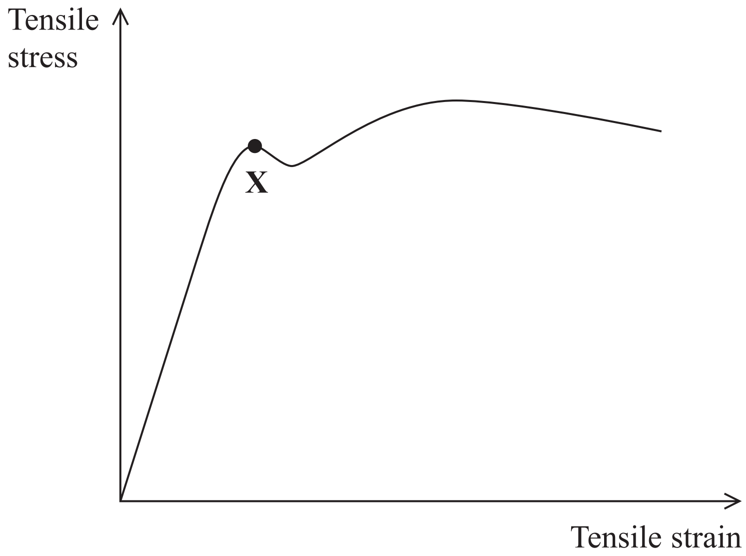
☒ **C**

☒ **D**

(Total for Question 8 = 1 mark)

9 A copper rod was placed under tensile stress and the tensile strain in the rod was measured.

The graph shows how the tensile stress required to cause a tensile strain in the rod depends upon the tensile strain.

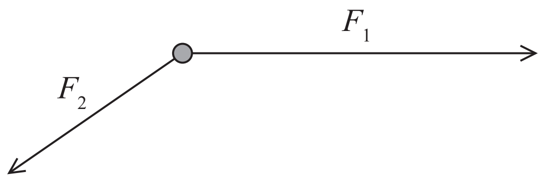


What does point X represent?

- ☒ **A** the fracture point of the rod
- ☒ **B** the limit of proportionality for copper
- ☒ **C** the maximum tensile stress in the rod
- ☒ **D** the yield point of copper

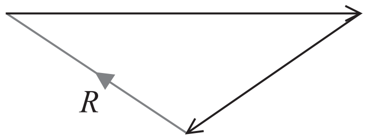
(Total for Question 9 = 1 mark)

10 Two forces F_1 and F_2 act on an object, as shown.

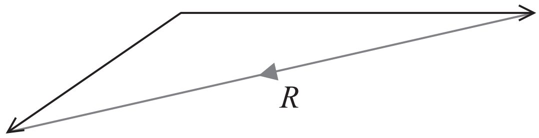


Which of the following is a correctly drawn scaled vector diagram for the resultant R of the forces F_1 and F_2?

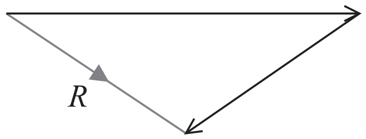
☒ **A**



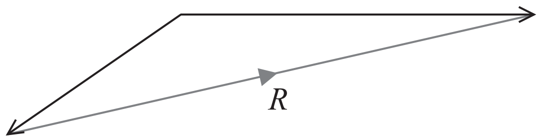
☒ **B**



☒ **C**



☒ **D**



(Total for Question 10 = 1 mark)

TOTAL FOR SECTION A = 10 MARKS

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SECTION B

Answer ALL questions in the spaces provided.

11 A railway carriage of mass 7.15×10^4 kg moving at $4.50\,m\,s^{-1}$ collides with a second railway carriage of mass 5.35×10^4 kg moving in the same direction.

The carriages join together. Immediately after the collision they move at a speed of $3.62\,m\,s^{-1}$.

(a) Show that the total momentum of the carriages immediately after the collision was approximately $4.5 \times 10^5\,kg\,m\,s^{-1}$.

(2)

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(b) Calculate the velocity of the second carriage before the collision.

(2)

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Velocity of second carriage = ...

(c) Calculate the change in total kinetic energy during the collision.

(2)

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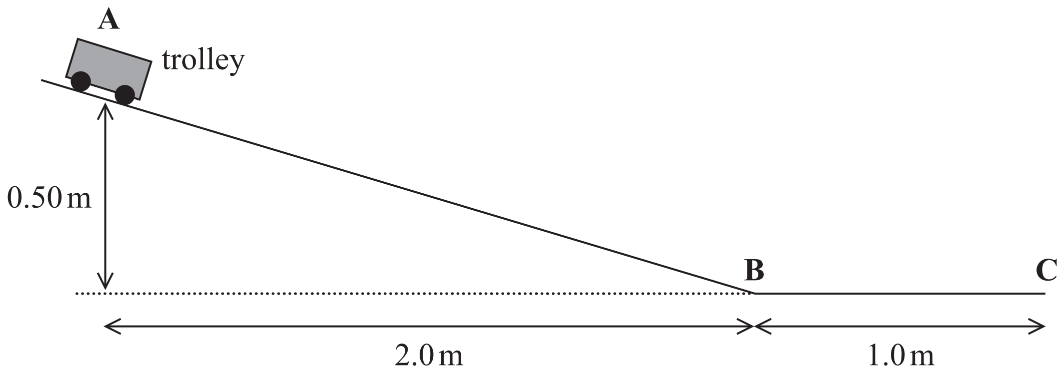
Change in total kinetic energy = ...

(Total for Question 11 = 6 marks)

12 A trolley accelerates from rest at point A, down a straight track to point B. The trolley then continues along a horizontal track to point C, as shown.



The effects of air resistance and friction are negligible.

(a) Show that the trolley reaches point B with a speed of about $3\,\mathrm{m\,s^{-1}}$.

(3)

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(b) Determine the time taken by the object to move from point A to point C.

(4)

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Time taken = ...

(Total for Question 12 = 7 marks)

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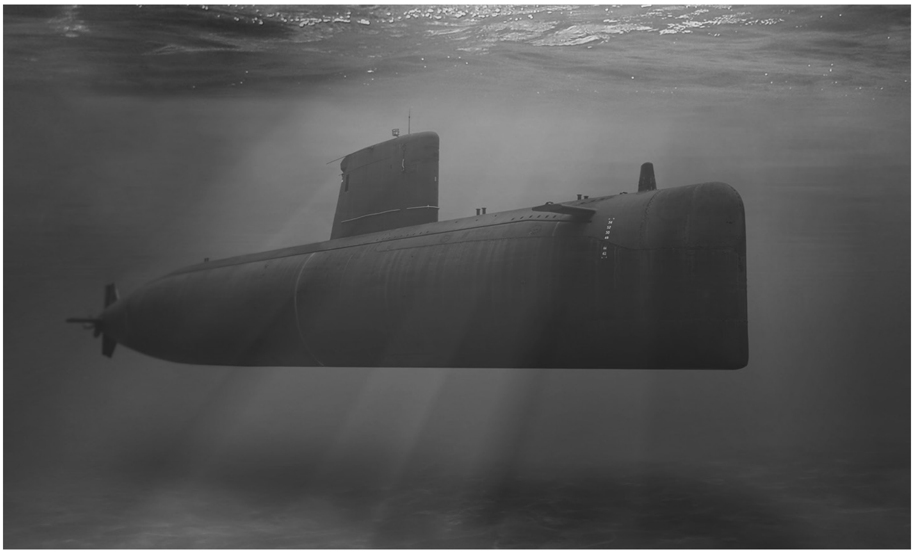
13 The photograph shows a submarine below the surface of the sea.



(Source: noraismail/Shutterstock)

(a) The submarine has a volume of $5.83 \times 10^3\,m^3$.

The submarine is stationary in a region of the sea where the density of the seawater is $1.03 \times 10^3\,kg\,m^{-3}$.

(i) Calculate the upthrust exerted on the submarine by the seawater.

(2)

Upthrust = ...

(ii) Explain why the mass of the submarine must be $6.0 \times 10^6\,kg$.

(2)

(b) The submarine now moves into a region of the sea where the water is less salty, and the density of the water reduces to $1.01 \times 10^3\,\mathrm{kg\,m^{-3}}$.

(i) Explain what would happen to the submarine as it moves into this region of lower density seawater.

(3)

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(ii) The submarine alters its weight by pumping water in or out of its internal tanks.

Determine the mass of water that the submarine should pump, in or out of its tanks, to maintain its depth below the surface of the sea.

(2)

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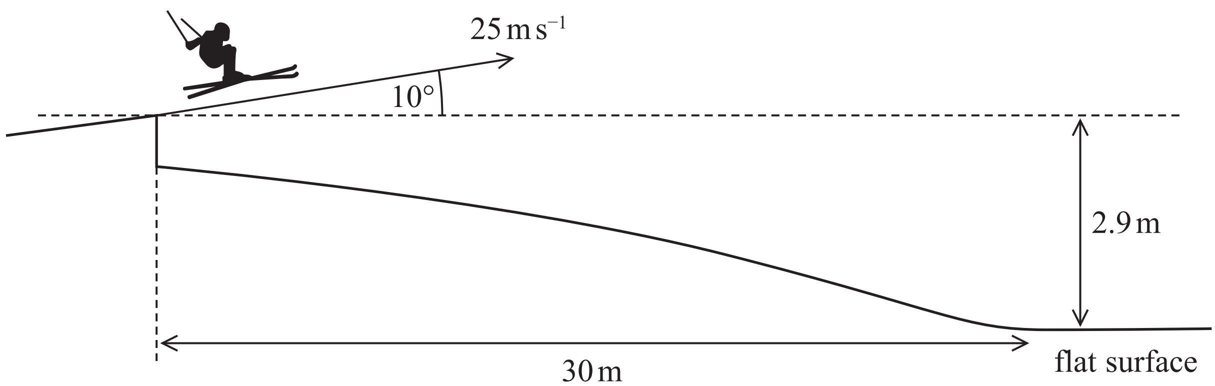
Mass of water = ...

(Total for Question 13 = 9 marks)

14 A skier moving at 25 m s^{-1} skis off a ramp. The ramp is angled upwards at 10° to the horizontal, as shown.

There is a flat surface that starts 30 m from the ramp. The flat surface is 2.9 m below the ramp.



(a) Deduce whether the skier reaches the flat surface before landing. You may ignore any effects of air resistance.

(5)

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(b) Another skier travels along the horizontal surface with an initial speed of $23\,m\,s^{-1}$.
She comes to rest after travelling a distance of 43 m.

Calculate the average force required to bring the skier to rest.

mass of skier = 63 kg

(3)

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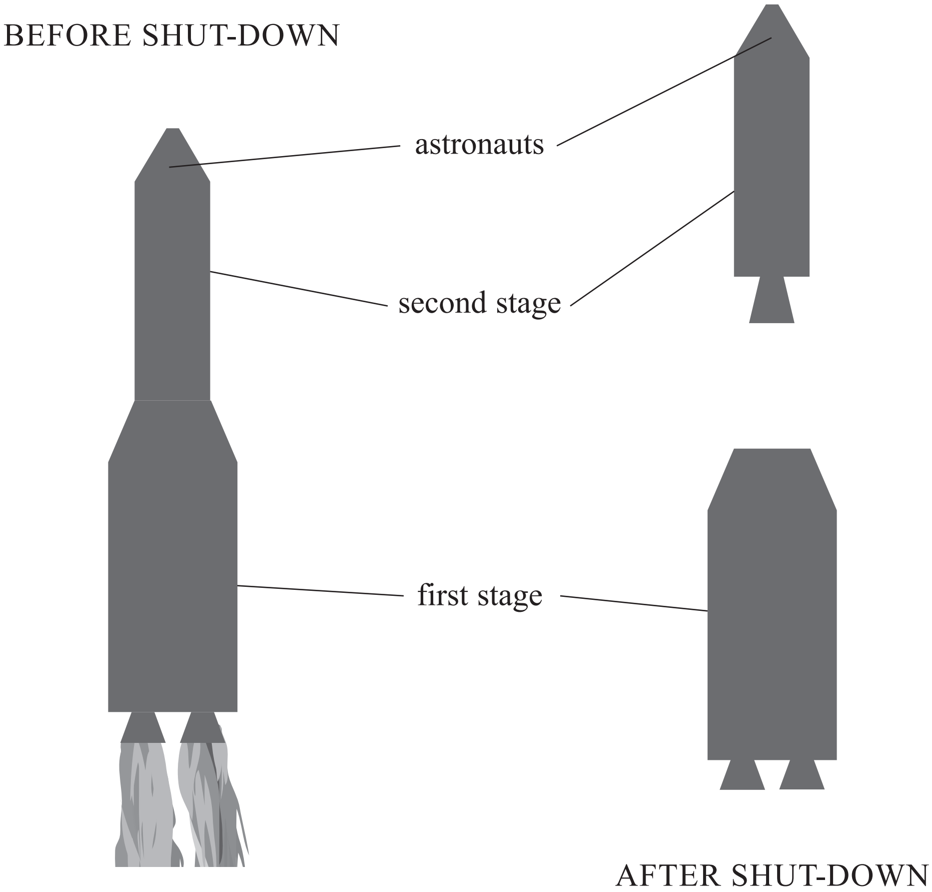
Average force = ...

(Total for Question 14 = 8 marks)

***15** A large spacecraft is made up of several 'stages'. Each stage consists of a rocket motor and a fuel tank. Once a stage has used all its fuel, the rocket motor in that stage shuts down. The stage then disconnects from the spacecraft and falls back to Earth.



As the rocket is rising due to the upward force of the first stage, an astronaut feels himself pushed further and further back, compressing the back of his seat.

When the first stage shuts down, the astronaut is suddenly projected forwards by the seat. The astronaut is held in place by a safety strap.

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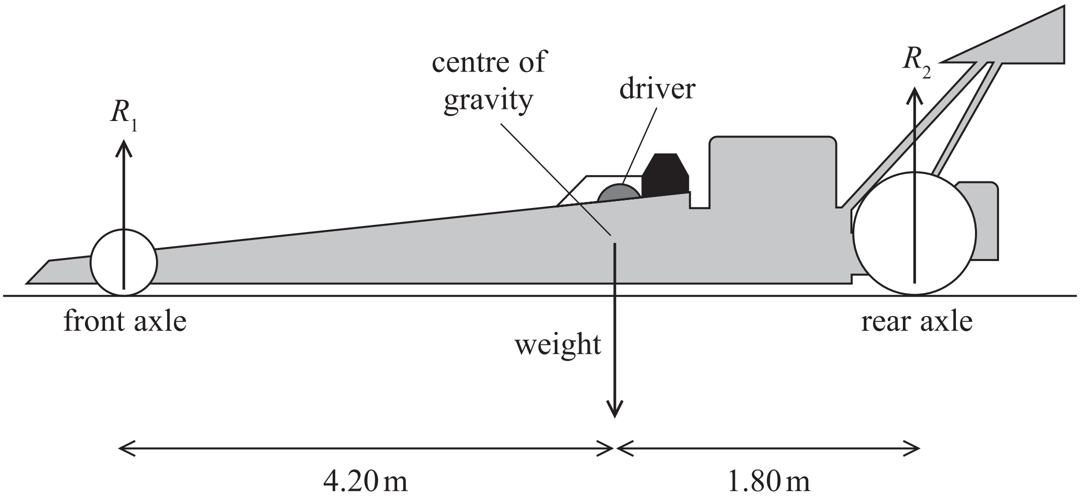
Explain the effects experienced by the astronaut. You may assume that the force provided by the first stage rocket motor is constant until the moment it shuts down.

(Total for Question 15 = 6 marks)

16 A dragster is a racing car designed for a very short race along a completely straight track, so must be able to accelerate at a very high rate. The dragster and driver shown below have a combined weight of 1.23×10^4 N. The centre of gravity is 1.80 m in front of the rear axle.



The front axle of the dragster is 6.00 m from the rear axle.

(a) Calculate the reaction forces R_1 and R_2, shown on the diagram, when the dragster is stationary and not accelerating.

(3)

R_1 = ...

R_2 = ...

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(b) When the dragster starts, there is a driving force that gives the dragster an initial forward acceleration of $5.50\,g$.

Calculate the initial driving force on the dragster.

(2)

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Initial driving force = ...

(c) The power from the car's engine is constant.

Explain how the force from the engine varies as the car accelerates.

(2)

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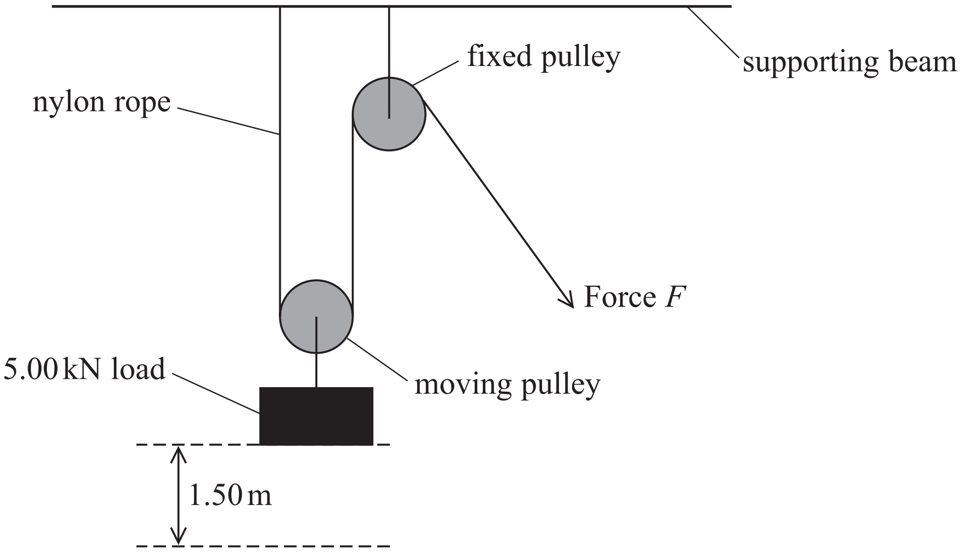
(Total for Question 16 = 7 marks)

17 A pulley system is used to lift a 5.00 kN load through a height of 1.50 m. The system consists of one fixed pulley and the other pulley can move. The pulleys are connected by a nylon rope, as shown.



The nylon rope will stretch when it is used in this way. The weight of the pulleys and the rope can be ignored, and you may assume that there is no friction in the pulleys.

The properties of the nylon rope are:

Young modulus of nylon	2.70 GPa
overall length of rope before adding the load	6.00 m
area of cross-section	$3.00 \times 10^{-4}\,\text{m}^2$

(a) The greater the length of a rope, the smaller the stiffness of the rope.

Explain why.

(2)

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(b) (i) Show that the stiffness k of the nylon rope is about $1.4 \times 10^5\,\text{N m}^{-1}$.

(3)

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(ii) The pulley system lifts the 5.00 kN weight at a steady rate.

Determine the extension of the rope while the lift is taking place.

(3)

Extension of rope = ...

(iii) Calculate the work done in stretching the rope.

(2)

Work done in stretching rope = ...

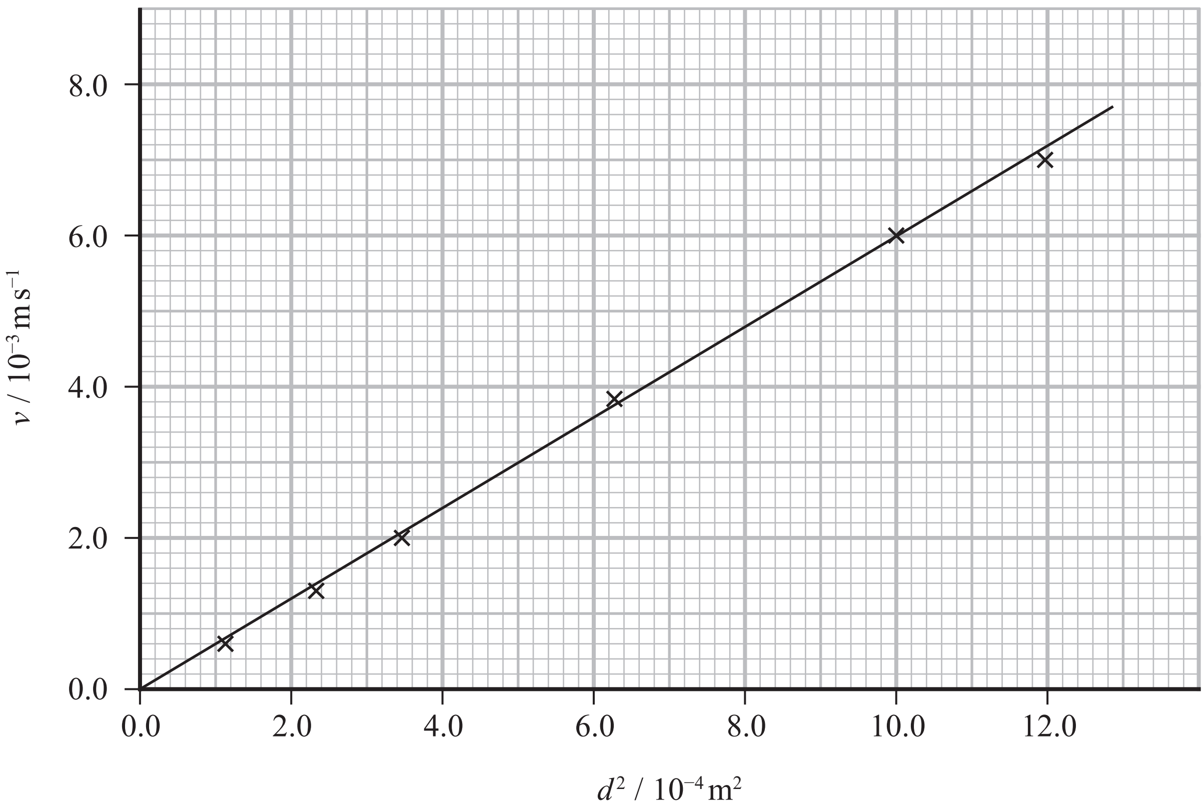
(c) Assess whether the stretching of the rope has a significant effect on the efficiency of the pulley system.

(2)

(Total for Question 17 = 12 marks)

18 A student carried out an experiment to determine the viscosity of a liquid. He measured the terminal velocities v of several different glass spheres of diameter d, as they fell through the liquid.

The student used his measurements to plot the graph of v against d^2 shown below.



(a) Explain what is meant by terminal velocity.

(2)

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(b) A glass sphere of diameter 35 mm is travelling through the fluid at terminal velocity.

Show that the drag force on this sphere is about 0.2 N.

density of glass $\rho_g = 2.52 \times 10^3\,\text{kg}\,\text{m}^{-3}$
density of liquid $\rho_s = 1.43 \times 10^3\,\text{kg}\,\text{m}^{-3}$

(5)

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(c) The student reads in a textbook that if Stokes' law is obeyed

$$v = kd^2$$

where k is a constant.

(i) Deduce from the graph whether the flow of liquid around the spheres was laminar.

(3)

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(ii) Determine a value for k using the student's graph.

(3)

k = ...

(iii) The constant k is given by

$$k = \frac{(\rho_g - \rho_s)g}{18\eta}$$

where η is the viscosity of the liquid.

Determine a value for η.

density of glass $\rho_g = 2.52 \times 10^3\,\text{kg}\,\text{m}^{-3}$
density of liquid $\rho_s = 1.43 \times 10^3\,\text{kg}\,\text{m}^{-3}$

(2)

η = ...

(Total for Question 18 = 15 marks)

TOTAL FOR SECTION B = 70 MARKS
TOTAL FOR PAPER = 80 MARKS

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List of data, formulae and relationships

Acceleration of free fall	$g = 9.81\ \text{m s}^{-2}$	(close to Earth's surface)
Boltzmann constant	$k = 1.38 \times 10^{-23}\ \text{J K}^{-1}$	
Coulomb's law constant	$k = 1/4\pi\varepsilon_0$	
	$= 8.99 \times 10^{9}\ \text{N m}^2\ \text{C}^{-2}$	
Electron charge	$e = -1.60 \times 10^{-19}\ \text{C}$	
Electron mass	$m_e = 9.11 \times 10^{-31}\ \text{kg}$	
Electronvolt	$1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$	
Gravitational constant	$G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$	
Gravitational field strength	$g = 9.81\ \text{N kg}^{-1}$	(close to Earth's surface)
Permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$	
Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$	
Proton mass	$m_p = 1.67 \times 10^{-27}\ \text{kg}$	
Speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \text{m s}^{-1}$	
Stefan-Boltzmann constant	$\sigma = 5.67 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$	
Unified atomic mass unit	$u = 1.66 \times 10^{-27}\ \text{kg}$	

Unit 1

Mechanics

Kinematic equations of motion

$$s = \frac{(u + v)t}{2}$$

$$v = u + at$$

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

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

Forces

$$\Sigma F = ma$$

$$g = \frac{F}{m}$$

$$W = mg$$

Momentum

$$p = mv$$

Moment of force

$$\text{moment} = Fx$$

Work and energy

$$\Delta W = F\Delta s$$

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

$$\Delta E_{grav} = mg\Delta h$$

Power

$$P = \frac{E}{t}$$

$$P = \frac{W}{t}$$

Efficiency

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$$

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

Materials

Density $\rho = \frac{m}{V}$

Stokes' law $F = 6\pi\eta rv$

Hooke's law $\Delta F = k\Delta x$

Elastic strain energy $\Delta E_{el} = \frac{1}{2}F\Delta x$

Young modulus $E = \frac{\sigma}{\varepsilon}$ where

Stress $\sigma = \frac{F}{A}$

Strain $\varepsilon = \frac{\Delta x}{x}$