Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
|---|---|
| | |

**Pearson Edexcel**
**International Advanced Level**

Centre Number | Candidate Number

# Friday 8 January 2021

Morning (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, ruler

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.

*Turn over* ▶

P65800A

1/1/1/

P 6 5 8 0 0 A 0 1 2 8

Pearson

DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA DO NOT WRITE IN THIS AREA

## 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** A car is moving towards a stop sign at a speed of $25\,\mathrm{m\,s^{-1}}$. The driver applies the brakes 20 m before the sign and decelerates uniformly to rest just before the sign.

Which of the following gives the magnitude of the car's deceleration in $\mathrm{m\,s^{-2}}$?

☒ **A** $\frac{25}{40}$

☒ **B** $\frac{25}{20}$

☒ **C** $\frac{25^2}{40}$

☒ **D** $\frac{25^2}{20}$

**(Total for Question 1 = 1 mark)**

**2** An object of mass 8.2 kg, initially at rest, falls a vertical distance of 25 m through the air and has a final velocity of $20\,\mathrm{m\,s^{-1}}$.

Which of the following gives the energy in joules dissipated by air resistance?

☒ **A** $8.2 \times 9.81 \times 25$

☒ **B** $0.5 \times 8.2 \times 20^2 + 8.2 \times 9.81 \times 25$

☒ **C** $8.2 \times 9.81 \times 25 - 0.5 \times 8.2 \times 20^2$

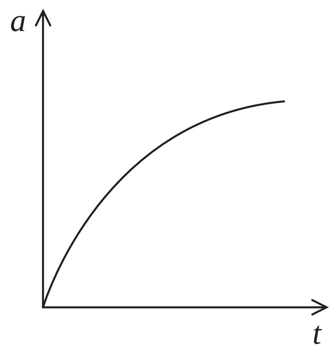
☒ **D** $0.5 \times 8.2 \times 20^2 - 8.2 \times 9.81 \times 25$

**(Total for Question 2 = 1 mark)**

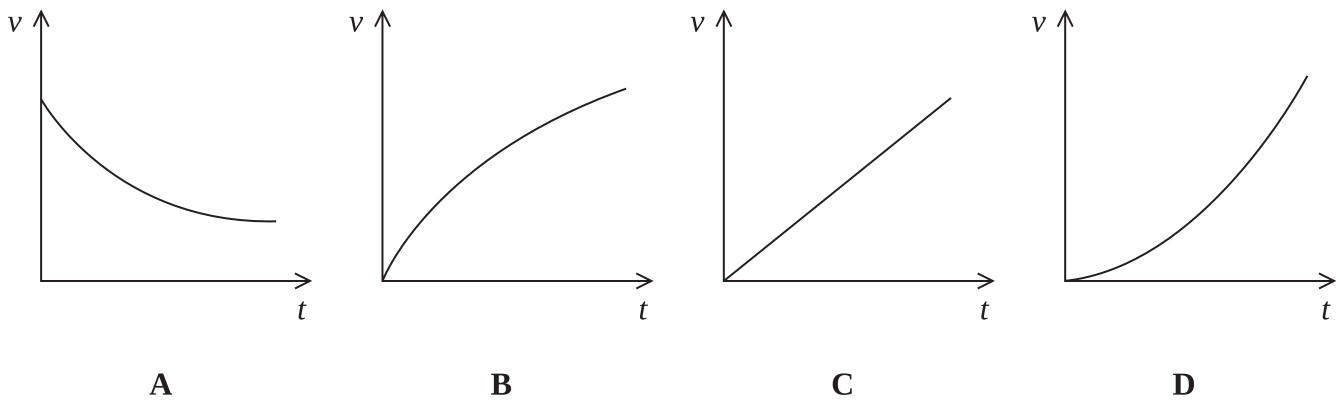


P 6 5 8 0 0 A 0 2 2 8

**3** The graph shows how the acceleration *a* of an object varies with time *t*.




Which of the following graphs shows how the velocity *v* of the object varies with *t*?




- ☒ **A**
- ☒ **B**
- ☒ **C**
- ☒ **D**

**(Total for Question 3 = 1 mark)**

**4** A student measures the time $t$ taken for a ball bearing to fall different measured distances $s$ from rest. The student uses his measurements to plot a graph with a gradient equal to the acceleration due to gravity $g$.

Which row of the table shows a graph with a gradient equal to $g$?

| | | *y*-axis | *x*-axis |
|---|---|---|---|
| ☒ | **A** | $s$ | $t^2$ |
| ☒ | **B** | $2s$ | $t^2$ |
| ☒ | **C** | $t^2$ | $s$ |
| ☒ | **D** | $t^2$ | $2s$ |

**(Total for Question 4 = 1 mark)**

---

**5** A student is investigating a material in the form of a wire.

Which of the following properties of the wire will change if a longer wire is used?

☒ **A** breaking stress

☒ **B** density

☒ **C** stiffness

☒ **D** Young modulus

**(Total for Question 5 = 1 mark)**

---

**6** Two objects are travelling directly towards each other and then collide. Object A is a mass of 2 kg initially travelling to the right at $3\,\mathrm{m\,s^{-1}}$ and object B is a mass of 5 kg initially travelling to the left at $2\,\mathrm{m\,s^{-1}}$.

What is the total momentum of A and B after the collision?

☒ **A** $4\,\mathrm{kg\,m\,s^{-1}}$ to the left

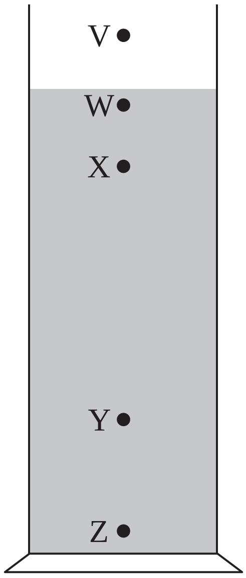
☒ **B** $4\,\mathrm{kg\,m\,s^{-1}}$ to the right

☒ **C** $16\,\mathrm{kg\,m\,s^{-1}}$ to the left

☒ **D** $16\,\mathrm{kg\,m\,s^{-1}}$ to the right

**(Total for Question 6 = 1 mark)**

**7** A student determines the terminal velocity of a ball bearing as it falls through oil. He releases the ball bearing at point V and measures the time taken for it to fall a measured distance.




Which two points should he use for the measured distance?

☒ **A** V and Y

☒ **B** W and Y

☒ **C** X and Y

☒ **D** W and Z

**(Total for Question 7 = 1 mark)**

**8** Which of the following is a vector quantity?

☒ **A** density

☒ **B** kinetic energy

☒ **C** momentum

☒ **D** viscosity

**(Total for Question 8 = 1 mark)**

---

**9** Which of the following statements is **not** correct for a Newton's 3rd Law pair of forces?

☒ **A** The forces act in opposite directions.

☒ **B** The forces act on the same body.

☒ **C** The forces are of the same type.

☒ **D** The forces have the same magnitude.

**(Total for Question 9 = 1 mark)**

---

**10** A locomotive pulls a train at constant speed against a force of 8 400 kN. The output power of the locomotive is 70 MW.

Which of the following gives the time in seconds for the locomotive to pull the train a distance of 1 km?

☒ **A** $\dfrac{70 \times 10^6}{8400 \times 10^3}$

☒ **B** $\dfrac{70}{8400 \times 10^3}$

☒ **C** $\dfrac{8.4 \times 10^6 \times 10^3}{7 \times 10^7}$

☒ **D** $\dfrac{8400}{70 \times 1000}$

**(Total for Question 10 = 1 mark)**

---

**TOTAL FOR SECTION A = 10 MARKS**

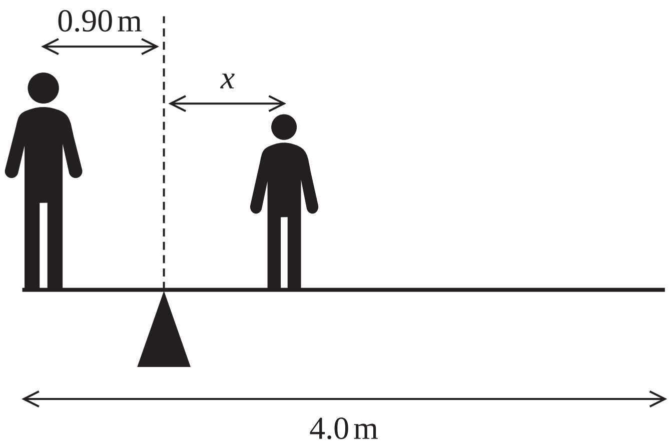
**BLANK PAGE**

**Section B begins on the next page.**

## SECTION B

**Answer ALL questions in the spaces provided.**

**11** A uniform plank of length 4.0 m is pivoted 0.90 m from one end. The weight of the plank is 250 N. A person of weight 950 N stands at one end of the plank. A person of weight 650 N stands a distance $x$ from the pivot so that the plank is in equilibrium, as shown.




(a) Add to the diagram to show the forces acting on the plank.

**(2)**

(b) Calculate the distance $x$.

**(3)**

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

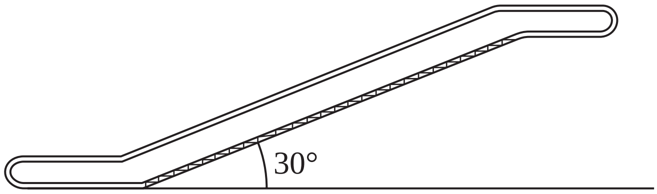
..............................................................................................................................................

$x$ = ..........................................................

**(Total for Question 11 = 5 marks)**

**12** Moving walkways are often found in airports. One moving walkway carries passengers up an incline of 30°, as shown.

(Source: © ilolab/Shutterstock.)




(a) A single passenger of mass 72 kg stands on the walkway. The speed of the walkway is $0.51\,\mathrm{m\,s^{-1}}$.

Show that the rate at which the walkway does work on the passenger is about 200 W.

**(3)**

.......................................................................................................................................

.......................................................................................................................................

.......................................................................................................................................

.......................................................................................................................................

.......................................................................................................................................

(b) The walkway system has an efficiency of 78%.

Calculate the power input to the system when 15 passengers of average mass 72 kg are standing on the walkway.

**(3)**

.......................................................................................................................................

.......................................................................................................................................

.......................................................................................................................................

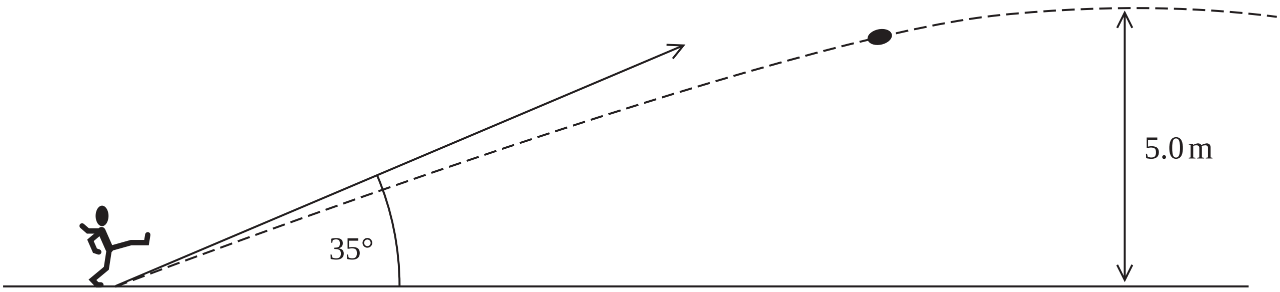
.......................................................................................................................................

.......................................................................................................................................

Power input = ..........................................

**(Total for Question 12 = 6 marks)**

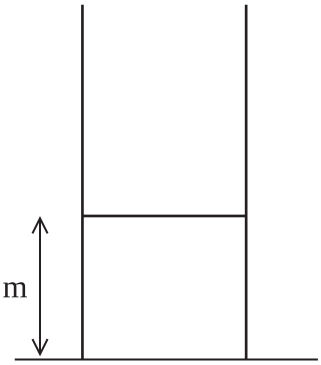
**13** A rugby player kicks a ball off the ground at an angle of 35.0° to the horizontal as shown. The ball reaches a maximum height of 5.0 m before returning to the ground.




(a) Show that the initial speed of the ball is about 17 m s$^{-1}$.

**(3)**

(b) After travelling a horizontal distance of 22.0 m the ball reaches the goal.




To score, the ball must be more than 3.00 m above the ground when it reaches the goal.

Deduce whether an initial speed of 17.0 m $s^{-1}$ is sufficient to score.

**(5)**

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

**(Total for Question 13 = 8 marks)**

**14** The photograph shows a fireboat used to put out fires on ships at sea. A pump, fixed to the boat, pumps water from the sea. The seawater is projected at high speed out of a pipe connected to the pump.

(Source: © Konrad Zelazowski/age fotostock/Superstock)

(a) The mass of seawater pumped each second is 300 kg. The pipe has a diameter of 10.0 cm.

density of seawater = $1030\,\text{kg}\,\text{m}^{-3}$

(i) Show that the speed at which the seawater is projected from the pipe is about $37\,\text{m}\,\text{s}^{-1}$.

**(4)**

..........................................................................................................................................................

..........................................................................................................................................................

..........................................................................................................................................................

..........................................................................................................................................................

..........................................................................................................................................................

..........................................................................................................................................................

..........................................................................................................................................................

..........................................................................................................................................................

(ii) Determine the rate at which the momentum of the seawater is changed by the pump. You may assume that the seawater is initially stationary.

**(2)**

....................................................................................................................................................

....................................................................................................................................................

....................................................................................................................................................

Rate of change of momentum = ..............................

(b) Projecting water from the pipe causes a force to be exerted on the pump.

Explain the direction of the force on the pump.

**(2)**

....................................................................................................................................................

....................................................................................................................................................

....................................................................................................................................................

....................................................................................................................................................

(c) Initially the pump is turned off and the fireboat moves forwards through the water at a constant speed. The boat's engine provides a constant forward force.

When the pump is turned on, water is projected forwards and the fireboat slows to a lower constant speed.

Explain why the boat now has a lower constant speed.
Your answer should refer to all the horizontal forces on the boat.

**(3)**

....................................................................................................................................................

....................................................................................................................................................

....................................................................................................................................................

....................................................................................................................................................

....................................................................................................................................................

....................................................................................................................................................

....................................................................................................................................................

**(Total for Question 14 = 11 marks)**

***15** In a bungee jump, the bungee jumper falls from a high platform while attached to an elastic cord. The cord is also attached to the platform.

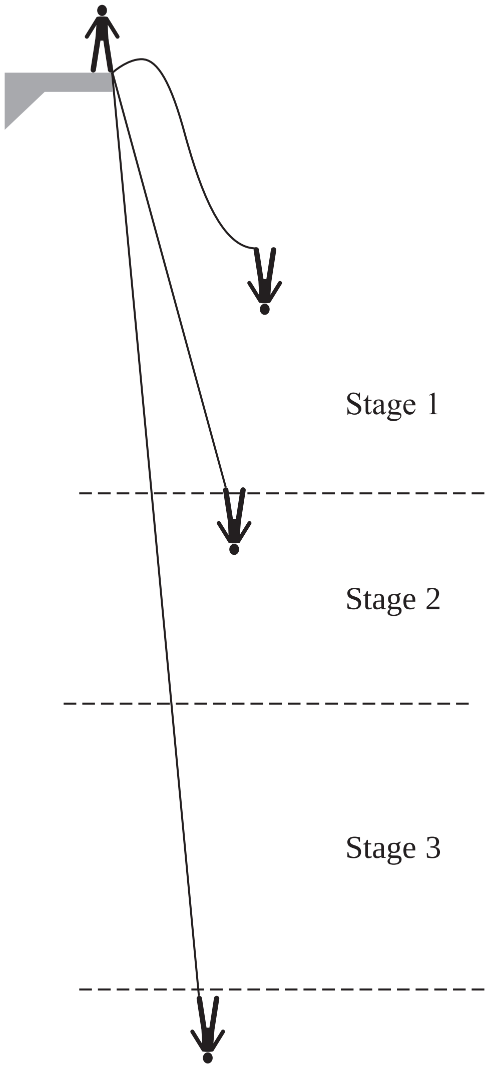
The cord slows the bungee jumper down, so that he comes to rest before reaching the ground.

The fall can be divided into three stages:

Stage 1 – the jumper is in free fall until the cord starts to stretch.

Stage 2 – the cord is stretching until the acceleration of the jumper decreases to zero.

Stage 3 – the cord continues to stretch until the jumper is momentarily at rest.



Explain, in terms of work done, how the kinetic energy of the bungee jumper changes during the three stages of the fall.

**(6)**

**(Total for Question 15 = 6 marks)**

**16** A steadily increasing tensile force was applied to a sample of a titanium alloy.

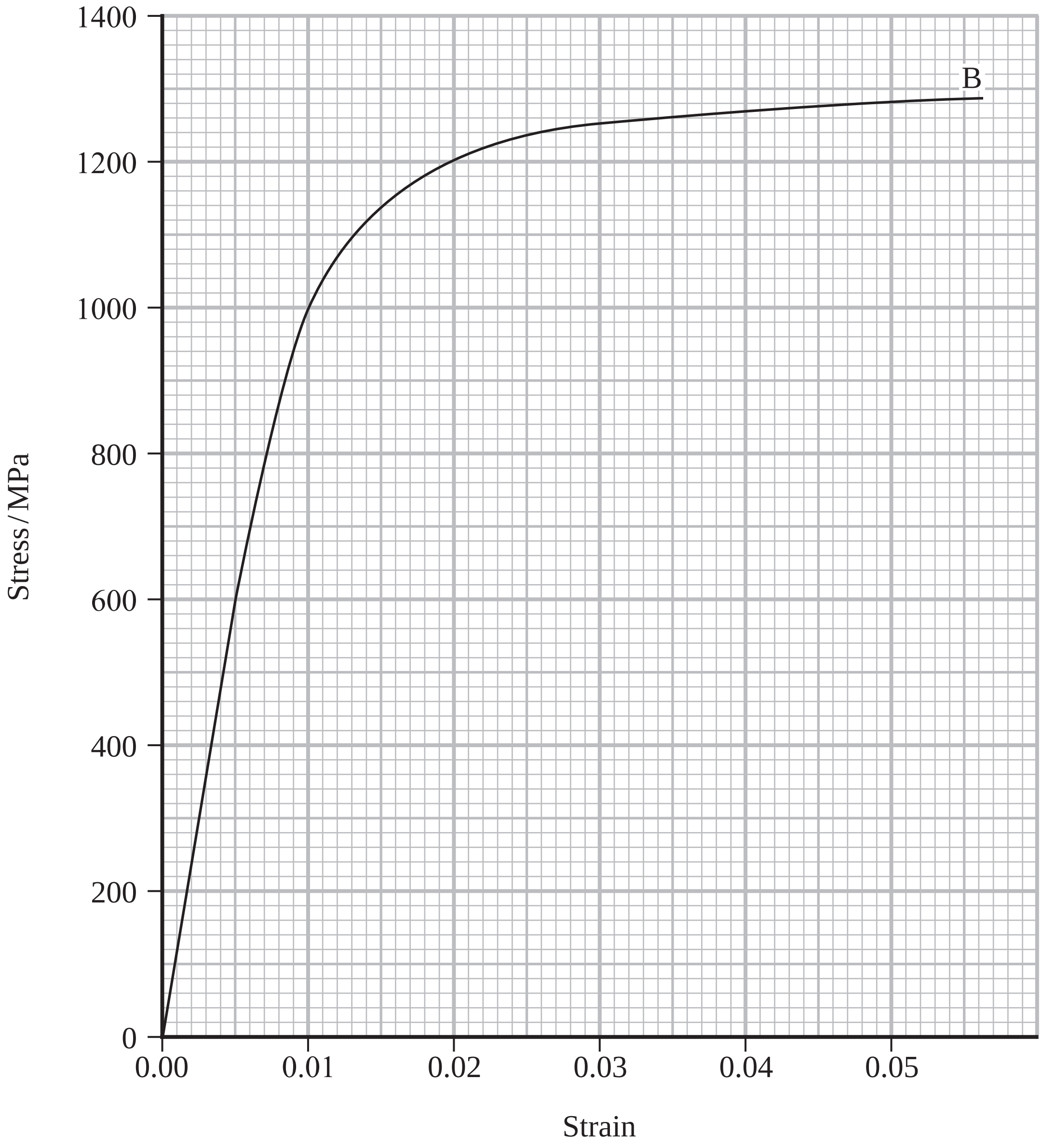
The sample had an original length of 40.0 cm and diameter of 5.05 mm.

(a) State a suitable measuring instrument to measure the diameter of the sample.

**(1)**

.......................................................................................................................................................................................................

(b) The graph shows how stress varied with strain for the sample.



(i) Determine the Young modulus of the sample.

**(3)**

Young modulus = ....................................................

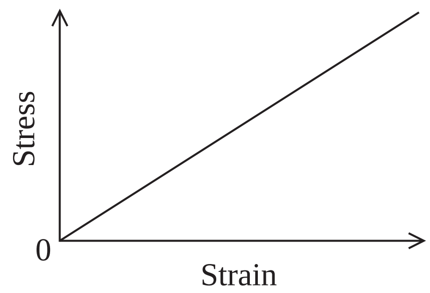
(ii) The sample broke at point B.

Determine the force required to break the sample.

**(4)**

Force = ....................................................

(iii) The graph below shows a linear section of the stress-strain graph for the sample.




Show that the area under this graph represents the work done per unit volume in stretching the sample.

**(3)**

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

(iv) The area under any stress-strain graph represents the work done per unit volume.

Estimate the amount of work required to break the titanium alloy sample.

**(4)**

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

........................................................................................................................................

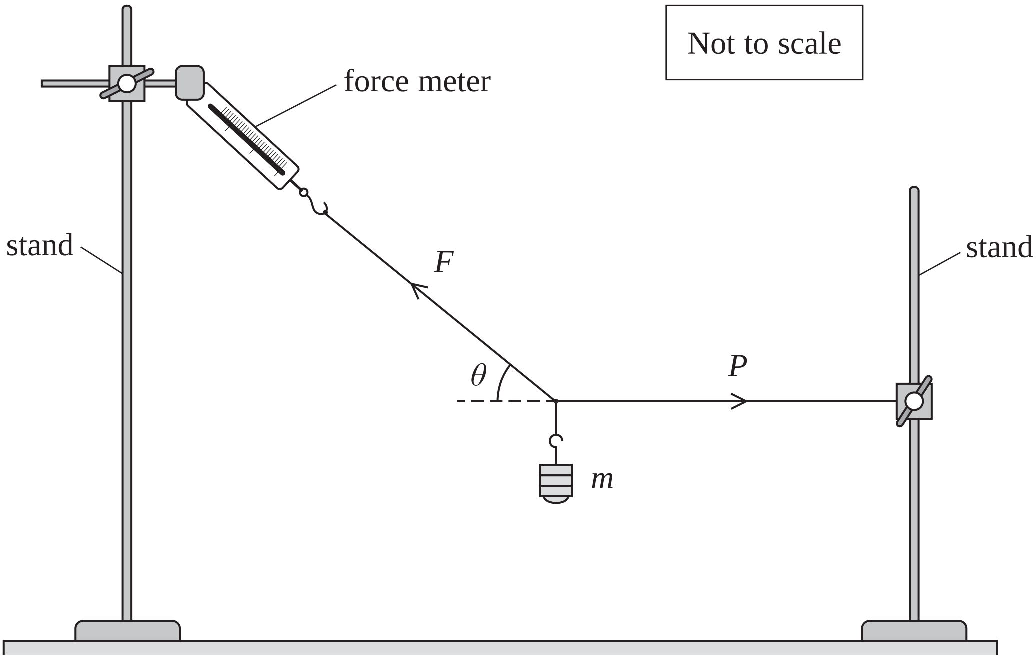
........................................................................................................................................

Work = ........................................................

**(Total for Question 16 = 15 marks)**

BLANK PAGE

**17** A mass $m$ is held in equilibrium by strings attached to two clamp stands. The force meter records the force $F$ in the upper string. The force in the horizontal string is $P$. The angle made by the upper string to the horizontal is $\theta$, as shown.




(a) The force meter allows force to be measured by means of Hooke's law.

The extension of the spring inside the force meter allows the stretching force to be read from a scale.

When the force applied to stretch the spring is 15 N the extension of the spring is 8.0 cm.

Show that the stiffness of the spring is about $2\,\mathrm{N\,cm^{-1}}$.

**(2)**

........................................................................................................................................................................................................

........................................................................................................................................................................................................

........................................................................................................................................................................................................

(b) When $m$ is equal to 0.55 kg, the value of $P$ is 8.5 N.

Calculate the value of $\theta$, and the extension of the spring in the force meter.

**(6)**

$\theta$ = ..........................................

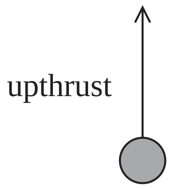
Extension of the spring = ..........................................

**(Total for Question 17 = 8 marks)**

**18** A spherical polystyrene bead is immersed in oil. The bead has diameter $4.00 \times 10^{-3}$ m. The bead is released and moves upwards through the oil at a constant velocity.

(a) Complete the free body force diagram below to show all the forces acting on the polystyrene bead.

**(2)**




(b) Show that the upthrust the oil exerts on the bead is about $3.1 \times 10^{-4}$ N.

density of oil = $930\,\mathrm{kg\,m^{-3}}$

**(3)**

.......................................................................................................................................................................................

.......................................................................................................................................................................................

.......................................................................................................................................................................................

.......................................................................................................................................................................................

.......................................................................................................................................................................................

.......................................................................................................................................................................................

(c) Stokes' law shows how the viscous drag on a sphere is related to its velocity through a fluid.

Stokes' law is only valid if the bead is moving sufficiently slowly through the oil.

(i) State the reason for this condition.

**(1)**

.......................................................................................................................................................................................

.......................................................................................................................................................................................

.......................................................................................................................................................................................

(ii) For Stokes' law to be valid the speed of the bead through the oil must be less than $v_R$, where

$$v_R = \frac{10 \times \text{viscosity of oil}}{\text{density of oil} \times \text{diameter of the bead}}$$

Deduce whether Stokes' law can be applied to this bead.

viscosity of oil = $4.90 \times 10^{-2}$ Pa s
weight of polystyrene bead = $1.05 \times 10^{-5}$ N

**(5)**

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

..............................................................................................................................................

**(Total for Question 18 = 11 marks)**

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

## 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 | $k = 1/4\pi\varepsilon_0$ <br> $= 8.99 \times 10^{9}\ \text{N m}^2\ \text{C}^{-2}$ | |
| 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 $\varepsilon = \frac{\Delta x}{x}$

**BLANK PAGE**

**BLANK PAGE**

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

BLANK PAGE