Please check the examination details below before entering your candidate information

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

Centre Number | Candidate Number

# Pearson Edexcel International Advanced Level

## Friday 12 May 2023

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.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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 out** 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 the question 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* ▶

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## SECTION A

**Answer ALL questions.**

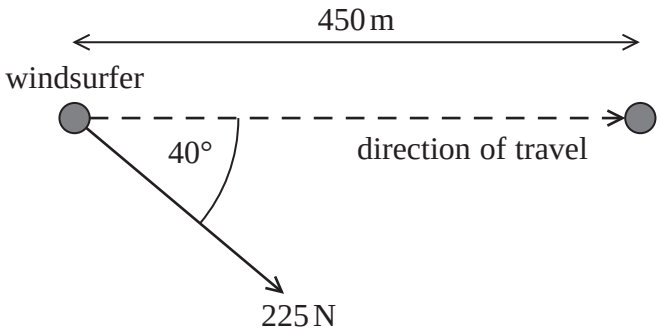
**For questions 1–10, in Section A, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.**

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

- ☒ **A** efficiency
- ☒ **B** kinetic energy
- ☒ **C** power
- ☒ **D** weight

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

**2** The wind exerts a force of 225 N on a windsurfer. The windsurfer moves a distance of 450 m at an angle of 40° to the wind, as shown.




Which of the following expressions gives the work done, in joules, on the windsurfer?

- ☒ **A** $225 \times 450$
- ☒ **B** $225 \times 450 \times \cos 40°$
- ☒ **C** $225 \times 450 \times \sin 40°$
- ☒ **D** $225 \times 450 \times \tan 40°$

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

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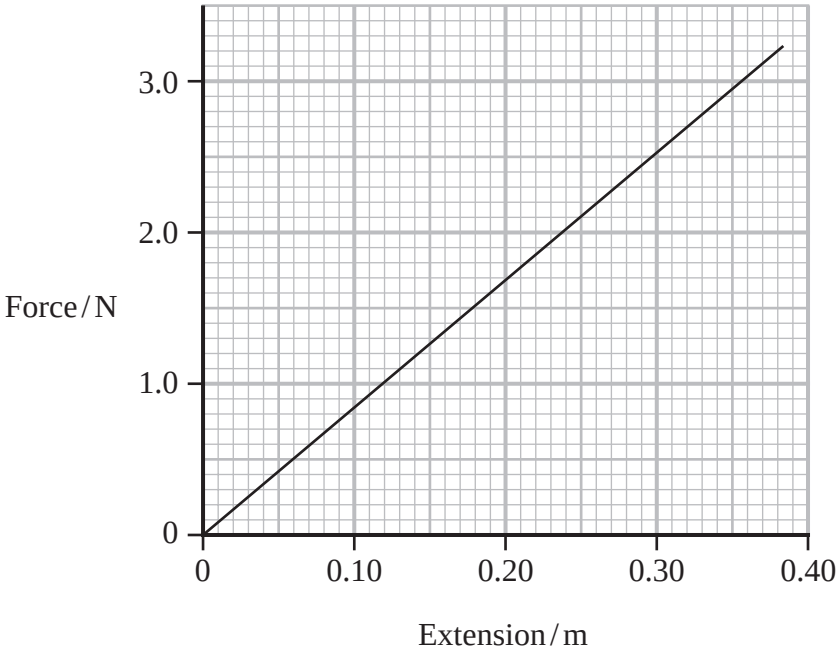
**3** A student applies a force to a copper wire.

Which row of the table shows the length and diameter of wire that would produce the greatest extension?

| | Length of wire | Diameter of wire |
|---|---|---|
| ☒ **A** | $x$ | $D$ |
| ☒ **B** | $x$ | $2D$ |
| ☒ **C** | $2x$ | $D$ |
| ☒ **D** | $2x$ | $2D$ |

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

**4** A force-extension graph for a spring is shown.




Which of the following gives the work done, in joules, to extend the spring by 0.30 m from its original length?

☒ **A** $0.30 \times 2.5$

☒ **B** $0.5 \times 0.30 \times 2.5$

☒ **C** $\frac{2.5}{0.30}$

☒ **D** $\frac{0.30}{2.5}$

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

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**5** Two forces form a Newton's third law pair.

Which of the following statements is **not** true?

☒ **A** The forces act on the same object.

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

☒ **C** The forces act for the same time.

☒ **D** The forces are the same type of force.

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

**6** A student determined the acceleration of free fall $g$.

She measured the time $t$ for a ball bearing to fall from rest through a distance $s$.
She repeated this for a range of values of $s$.

Which row of the table shows the graph that would give a gradient equivalent to $g$?

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

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

**7** A car travels with a velocity of $3\,\text{m s}^{-1}$. The car accelerates uniformly in a straight line for a distance of 15 m. The final velocity of the car is $5\,\text{m s}^{-1}$.

Which of the following expressions gives the acceleration of the car in $\text{m s}^{-2}$?

☒ **A** $\dfrac{5-3}{15}$

☒ **B** $\dfrac{5-3}{2\times 15}$

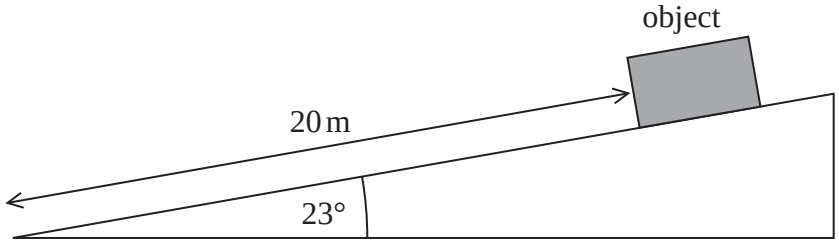
☒ **C** $\dfrac{5^2-3^2}{15}$

☒ **D** $\dfrac{5^2-3^2}{2\times 15}$

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

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**8** An object accelerates from rest down a frictionless slope. The object moves a distance of 20 m. The slope is at an angle of 23° to the horizontal, as shown.




Which of the following gives the final speed of the object in $m\,s^{-1}$?

- ☒ **A** $\sqrt{2 \times 9.81 \times 20 \times \cos 23°}$
- ☒ **B** $\sqrt{0.5 \times 9.81 \times 20 \times \cos 23°}$
- ☒ **C** $\sqrt{2 \times 9.81 \times 20 \times \sin 23°}$
- ☒ **D** $\sqrt{0.5 \times 9.81 \times 20 \times \sin 23°}$

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

**9** A ball bearing falls at terminal velocity through a liquid.

The temperature of the liquid increases and the ball bearing falls with a greater terminal velocity.

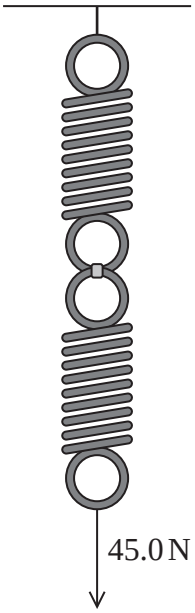
Which row of the table is correct as the temperature of the liquid increases?

| | Viscous drag on ball bearing | Viscosity of liquid |
|---|---|---|
| ☒ **A** | constant | increases |
| ☒ **B** | constant | decreases |
| ☒ **C** | decreases | increases |
| ☒ **D** | decreases | decreases |

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

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**10** Two identical springs are arranged in series. A force of 45.0 N is applied to the springs, as shown.




The springs extend a total distance of 15 mm.

Which of the following expressions gives the stiffness of each spring in $N\,mm^{-1}$?

☒ **A** $\frac{15}{2 \times 45}$

☒ **B** $\frac{45}{2 \times 15}$

☒ **C** $\frac{2 \times 15}{45}$

☒ **D** $\frac{2 \times 45}{15}$

**(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 rock falls from rest through a small distance $s$ to the surface of Mars. The rock hits Mars with velocity $v_M$.

Another rock falls from rest through distance $s$ to the surface of Earth and hits Earth with velocity $v_E$.

Calculate the ratio $\frac{v_M}{v_E}$.

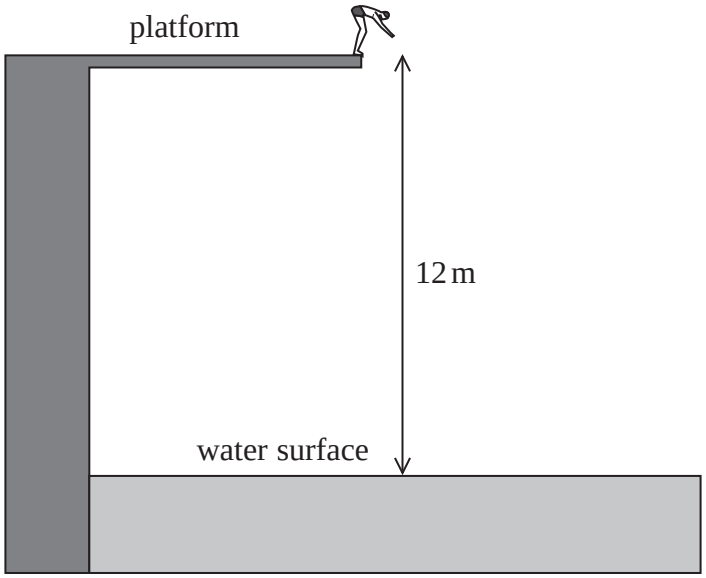
acceleration due to gravity on Mars = 0.38$g$

$\frac{v_M}{v_E}$ = .....

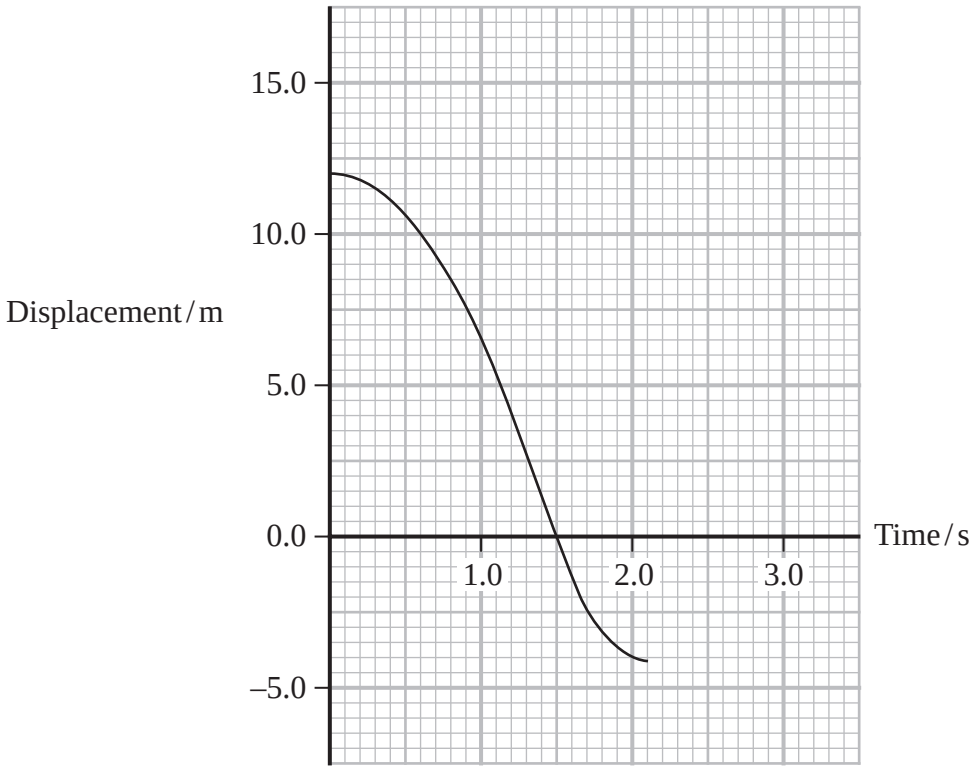
**(Total for Question 11 = 3 marks)**

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**12** A man dives from a platform into a swimming pool. The platform is 12 m above the water surface as shown.




The graph shows the vertical displacement of the man from the water surface, after leaving the platform.




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(a) (i) State how the graph shows that the man's initial vertical velocity is zero.

**(1)**

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(ii) Determine the vertical velocity of the man as he enters the water.

**(2)**

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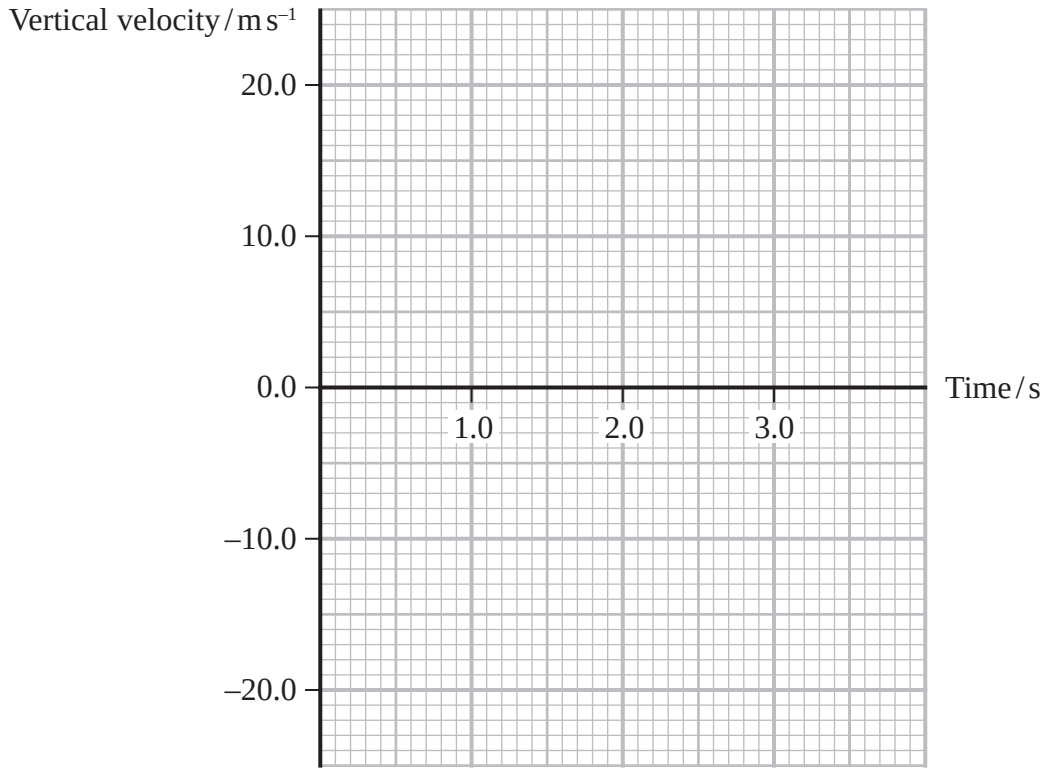
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Vertical velocity = .....

(b) Before entering the water, the man has a constant vertical acceleration.
After entering the water, the man has a constant vertical deceleration.

Draw the velocity-time graph for the man on the axes below.

**(2)**




**(Total for Question 12 = 5 marks)**

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**13** A high-speed train accelerates from rest along a straight horizontal track.

(a) The final speed of the train is $76\,m\,s^{-1}$.

Show that the useful work done to accelerate the train is about 2 GJ.

mass of train = $7.2 \times 10^5$ kg

**(2)**

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(b) The train accelerates for 180 s. The train has an input power of 16 MW while accelerating.

Determine the work done against air resistance as the train accelerates.

**(2)**

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Work done against air resistance = .....

**(Total for Question 13 = 4 marks)**

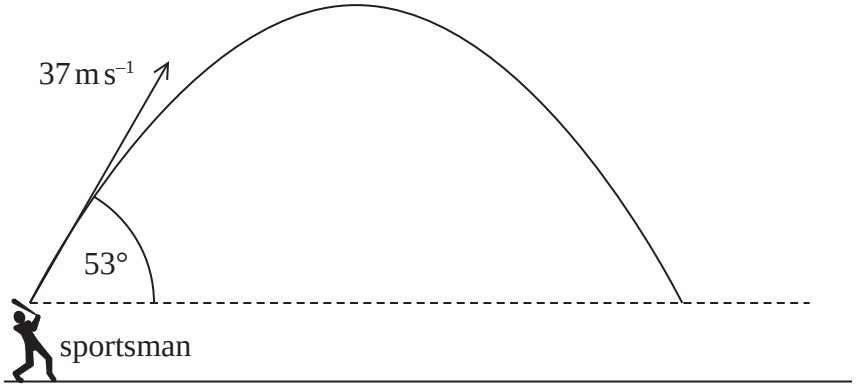
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**14** A sportsman hits a ball with a bat.

The ball leaves the bat at a speed of $37\,m\,s^{-1}$ at an angle of 53° to the horizontal, as shown.




Calculate the horizontal distance travelled by the ball before returning to the height it was hit from.

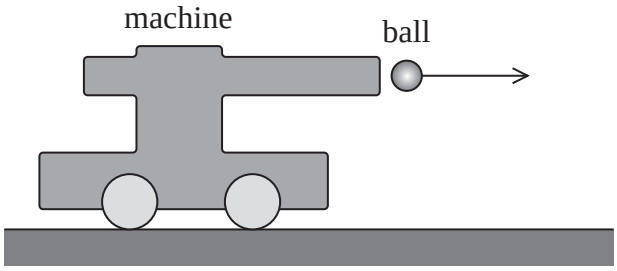
Horizontal distance = .....

**(Total for Question 14 = 4 marks)**

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**15** The diagram shows a machine used to launch tennis balls in a horizontal direction.

The machine is on frictionless wheels.




Before a tennis ball is launched, the machine is stationary.

(a) Explain, in terms of momentum, why the machine starts to move as the ball is launched.

**(3)**

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(b) Calculate the velocity of the machine just after the ball is launched.

velocity of ball = $4.5\,m\,s^{-1}$
mass of ball = 0.056 kg
mass of machine = 2.9 kg

**(3)**

Velocity of machine = .....

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

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**16** A small, spherical air bubble moves upwards in a glass of water. The drag force on the bubble can be calculated using Stokes' law.

(a) State the condition needed for Stokes' law to apply to the bubble.

**(1)**

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(b) The bubble moves upwards at a constant velocity.

The volume of the bubble is $5.3 \times 10^{-11}\,m^3$.

(i) Show that the upthrust on the bubble is about $5 \times 10^{-7}\,N$.

density of water = $998\,kg\,m^{-3}$

**(2)**

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(ii) The bubble moves upwards at a constant velocity of $0.035\,m\,s^{-1}$.

Deduce whether Stokes' law applies to the bubble.

You may ignore the weight of the bubble.

viscosity of water = $9.5 \times 10^{-4}\,Pa\,s$

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**(Total for Question 16 = 7 marks)**

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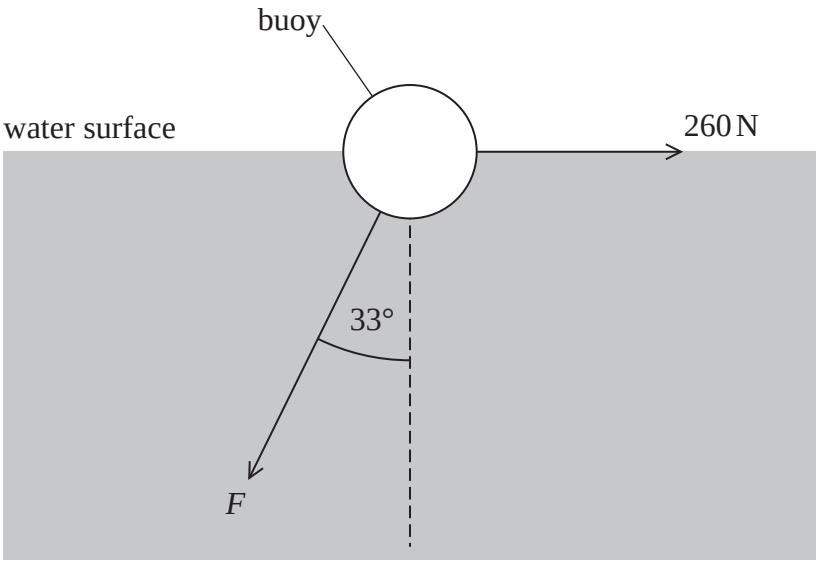
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**17** The photograph shows a floating object called a buoy. A long chain attaches the buoy to a very large mass at the bottom of the sea so that the buoy remains stationary.



(Source: © EThamPhoto / Alamy Stock Photo)

Water flowing past the buoy causes a horizontal force of 260 N on the buoy.
The chain exerts a force $F$ on the buoy at an angle of 33° to the vertical as shown.




(a) (i) Show that $F$ is about 500 N.

**(2)**

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(ii) The buoy floats due to the upthrust from the water.
The weight of water displaced by the buoy is 2.9 kN.

Determine the weight of the buoy.

**(3)**

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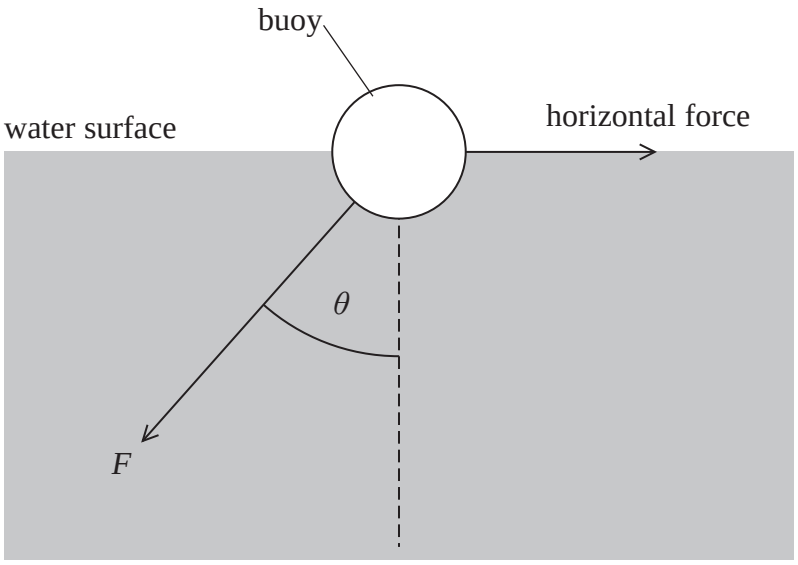
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Weight of buoy = .....

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(b) The speed of the water flowing past the buoy increases, so the horizontal force increases. Assume that the weight of water displaced by the buoy does not change.




Explain how $F$ and $\theta$ change when the horizontal force increases.

**(3)**

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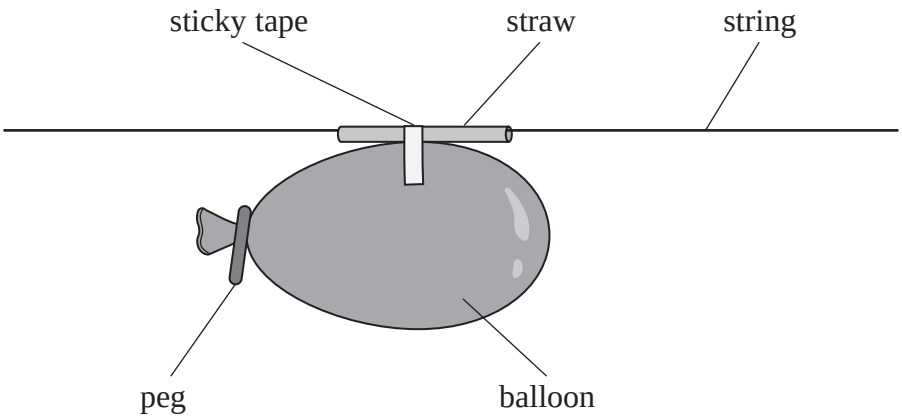
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**(Total for Question 17 = 8 marks)**

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***18** A student inflates a balloon. She uses a peg to keep the balloon closed. She then attaches a straw to the balloon using sticky tape.

She passes a string through the straw and pulls the string tight, as shown.




The student removes the peg and air leaves the balloon.

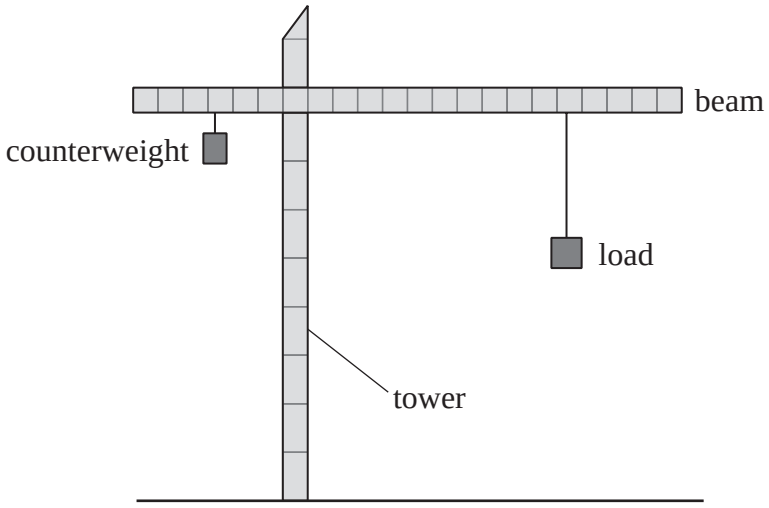
The velocity of the balloon increases from zero to a maximum.

Explain how Newton's three laws of motion apply to the motion of the balloon during this time.

**(Total for Question 18 = 6 marks)**

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**19** The diagram shows a crane lifting a load. There is a large mass called a counterweight attached to the crane, on the opposite side of the tower to the load.




(a) The crane has an electric motor with an efficiency of 47%.

The crane lifts a load of $4.4 \times 10^4$ N. The load moves through a vertical distance of 15 m in a time of 70 seconds.

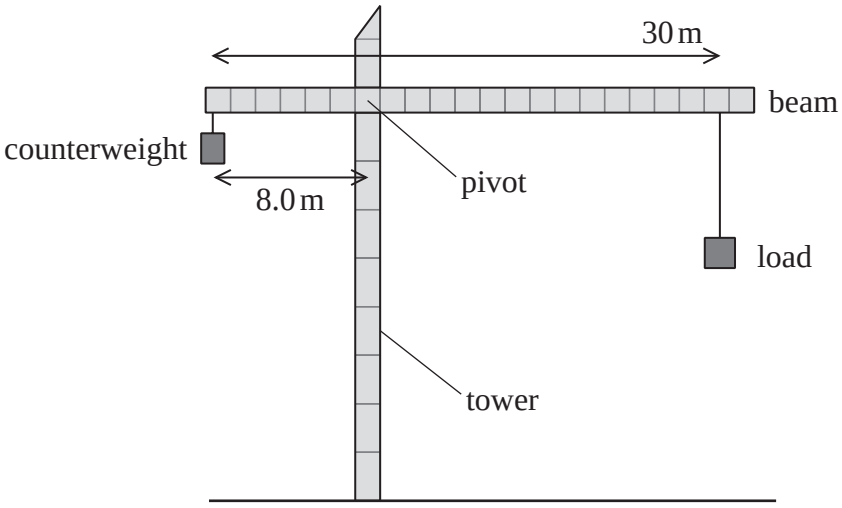
Determine the average power input to the electric motor.

**(4)**

Average power input = .....

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(b) The horizontal distance from the load to the tower can be changed. The horizontal distance from the counterweight to the tower can also be changed.




(i) Explain how the counterweight needs to move when the load is moved away from the tower.

**(4)**

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(ii) The beam is uniform with a weight of $3.0 \times 10^4$ N.
The counterweight has a weight of $1.1 \times 10^5$ N.
The load has a weight of $4.4 \times 10^4$ N.

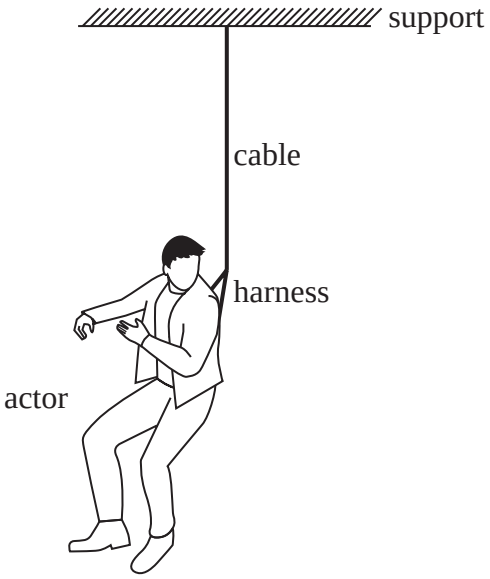
Deduce whether the load can be moved to the end of the beam without the crane toppling.

**(5)**

**(Total for Question 19 = 13 marks)**

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**20** An actor is wearing a harness. The harness is connected to a cable and support, as shown.




(a) The force on the cable must not cause the material of the cable to reach its yield point.

State what is meant by the yield point of a material.

**(1)**

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(b) The cable and harness are used to accelerate the actor vertically off the ground.

(i) Explain why the forces acting on the actor cause him to accelerate upwards.

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(ii) The actor has a mass of 77 kg and is lifted vertically from the ground with an acceleration of 2.1 m s$^{-2}$.

Show that the tension in the cable is about 920 N.

**(3)**

(iii) To make sure the actor is safe, the stress in the cable must be less than 15% of the yield point stress.

The cable has a yield point stress of $2.5 \times 10^{8}$ Pa.

The diameter of the cable is $7.6 \times 10^{-3}$ m.

Deduce whether it is safe to lift the actor with an acceleration of 2.1 m s$^{-2}$.

**(4)**

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(c) The original cable is replaced with a new cable made from a different material. This material has a lower Young modulus than the material used to make the original cable.

The new cable is the same length as the original cable but has a greater diameter.

The breaking stress is the same for both cables.

Explain how the work done to break the new cable is different from the work done to break the original cable. Assume that both materials obey Hooke's law up to the breaking point.

**(4)**

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**(Total for Question 20 = 14 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) |
| Gravitational field strength | $g = 9.81\ \text{N kg}^{-1}$ | (close to Earth's surface) |

***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

$$E = \frac{\sigma}{\varepsilon} \text{ where}$$

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

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

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