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# ***PHYSICS***

## ***2007***

### ***Trial Examination 1***

***Motion in one and two dimensions***

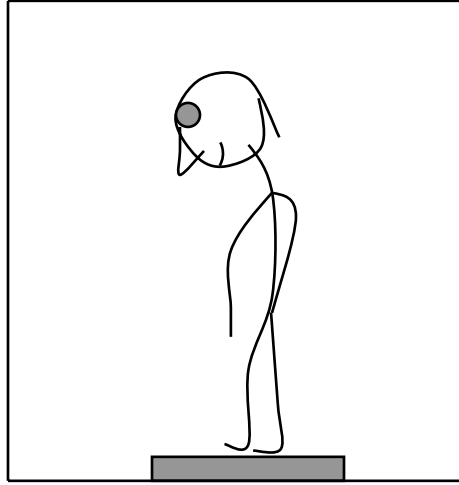
***Electronics and photonics***

***Investigating materials and their use in structures***

(Note: Use information in the formula data sheet supplied by VCAA)

## Area of study 1 – Motion in one and two dimensions

Tom (mass of 75 kg) measures his weight inside a moving elevator by standing on an accurate bathroom scale that is calibrated in kilogram. The reading shown on the scale is 72 kg. Take  $g = 10 \text{ N kg}^{-1}$ .



### Question 1

Calculate the apparent weight of Tom inside the moving elevator.

2 marks

### Question 2

Which **one or more** of the following statements **cannot** be true regarding the motion of the elevator?

2 marks

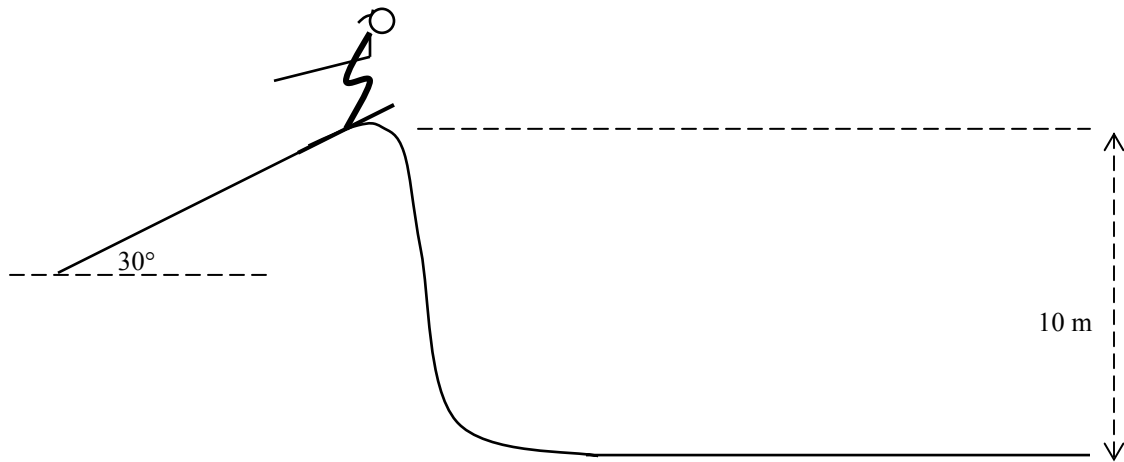
- A. The elevator moves downwards with increasing speed.
- B. The elevator moves downwards with decreasing speed.
- C. The elevator moves upwards with increasing speed.
- D. The elevator moves upwards with decreasing speed.
- E. The elevator is a non-inertial frame of reference.

### Question 3

Calculate the magnitude of the acceleration of the moving elevator.

3 marks

Tom skies off from the cliff edge at  $20 \text{ ms}^{-1}$ . Take  $g = 10 \text{ N kg}^{-1}$ . See the diagram below for other data. Ignore air resistance.



**Question 4**

Calculate the time between taking off and landing.

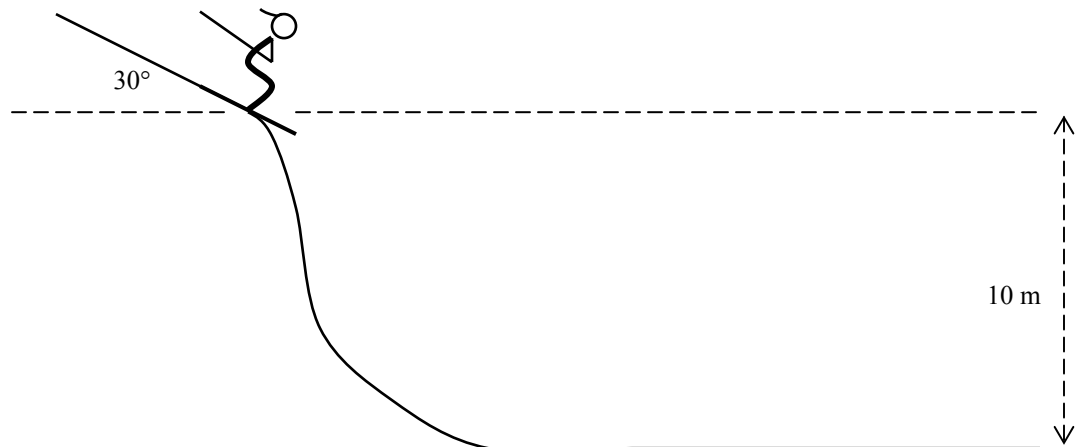
3 marks

**Question 5**

Calculate Tom's speed just before landing.

3 marks

Tom is about to sky off from another cliff edge at the same speed  $20 \text{ ms}^{-1}$ . Take  $g = 10 \text{ N kg}^{-1}$ . See the diagram below for other data. Ignore air resistance.



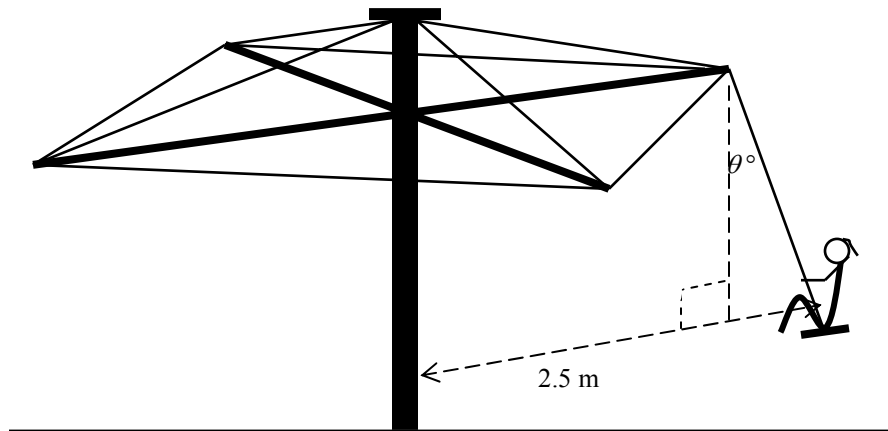
**Question 6**

Which one of the following statements is true when the second jump is compared with the first jump?

2 marks

- A. Tom will take longer time to land at a higher speed.
- B. Tom will take shorter time to land at a higher speed.
- C. Tom will take longer time to land at a lower speed.
- D. Tom will take shorter time to land at a lower speed.
- E. Tom will take longer time to land at the same speed.
- F. Tom will take shorter time to land at the same speed.

Tom junior (25 kg) uses the rotary hoist in the backyard as a merry-go-round rotating at  $2.0 \text{ ms}^{-1}$ . Take  $g = 10 \text{ N kg}^{-1}$ . See the diagram below for other data. Ignore air resistance.

**Question 7**

On the diagram above draw arrows (correct relative length and direction) to represent the two 'real' forces acting on Tom junior.

2 marks

**Question 8**

Calculate the net force on Tom junior.

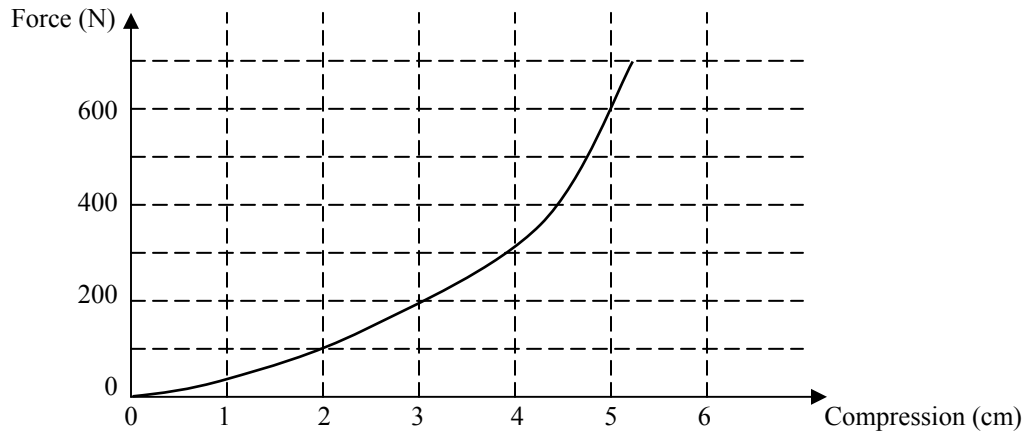
3 marks

**Question 9**

Calculate the angle  $\theta$  that the rope makes with the vertical.

2 marks

Tom found a spring in his garage. He investigated the force-compression relationship of the spring, which is shown in the following graph.



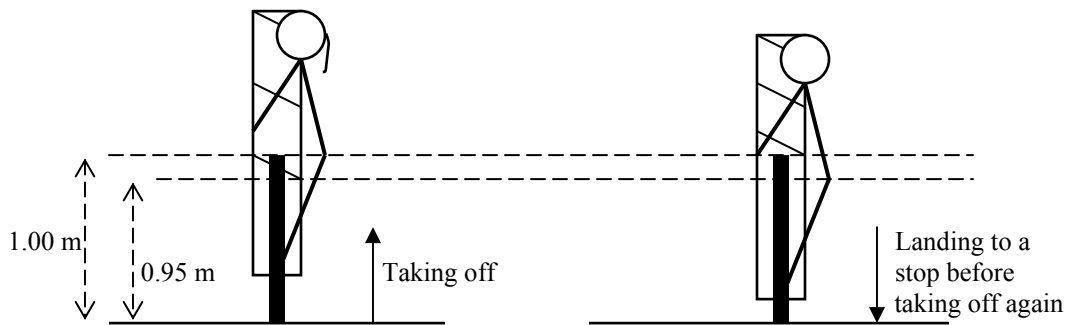
**Question 10**

Estimate the amount of work required to compress the spring by 5.0 cm.

3 marks

J

Tom made a pogo-stick out of the spring and some pipes for Tom junior. The total mass of Tom junior and the pogo-stick is 27 kg. In the next question heights are measured from the ground to the centre of mass of Tom junior and the pogo-stick. Tom junior was upright all the time during a vertical hop. Take  $g = 10 \text{ N kg}^{-1}$ . See the diagram below for other data. Ignore air resistance and friction.



**Question 11**

Tom junior's hair is missing in the second diagram above. Draw his hair pointing in the correct direction in the second diagram.

1 mark

**Question 12**

Calculate the maximum possible speed of Tom junior at take off.

3 marks

$\text{ms}^{-1}$

**Question 13**

At the moment just before Tom junior and the pogo-stick taking off again, which one of the following statements is true? 2 marks

- A. The acceleration of Tom and the pogo-stick is zero.
- B. The net force on Tom and the pogo-stick is pointing downwards.
- C. The net force on Tom and the pogo-stick is pointing upwards.
- D. The net force on Tom and the pogo-stick is at its minimum.

Tom and Tom junior decide to go space travel for A\$5,000,000. They are in a space ship travelling in circular orbit around the earth, completing one revolution in 12 hours.

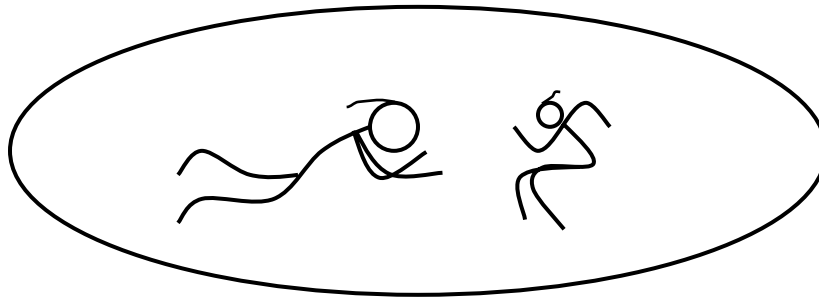
**Question 14**

Calculate the speed of the space ship relative to the centre of the earth. 3 marks

**Question 15**

Calculate Tom's weight while he is in orbit around the earth. 3 marks

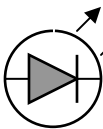
Tom (75 kg) and Tom junior (25 kg) are at rest inside the space ship. Tom pushes Tom junior with an average force of 5.0 N for 1.2 s.

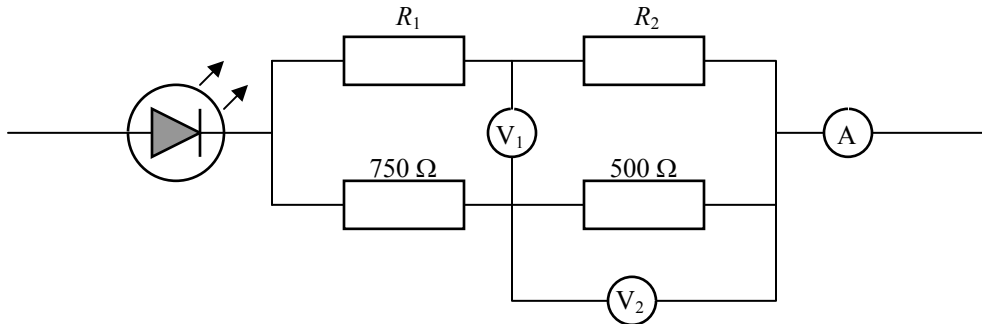
**Question 16**

Calculate the speed of Tom junior relative Tom when they are apart. 3 marks

**Area of study 2 – Electronics and photonics**

The following diagram shows a small part of a complicated circuit, where

(A) and (V) represent ammeter and voltmeter respectively,  an ohmic resistor, and  a LED.



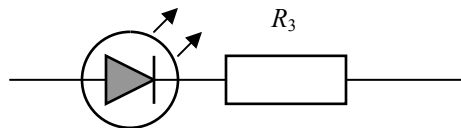
The meter readings are  $V_1 = 0$  volts,  $V_2 = 2.4$  volts and  $A = 10.8$  milli-amperes.

**Question 1**

Determine the value of the ratio  $\frac{R_1}{R_2}$ .

3 marks

The above circuit (with the meters removed) can be simplified to the one shown below, where the same LED is used.



**Question 2**

Calculate the value of  $R_3$ .

3 marks

  $\Omega$

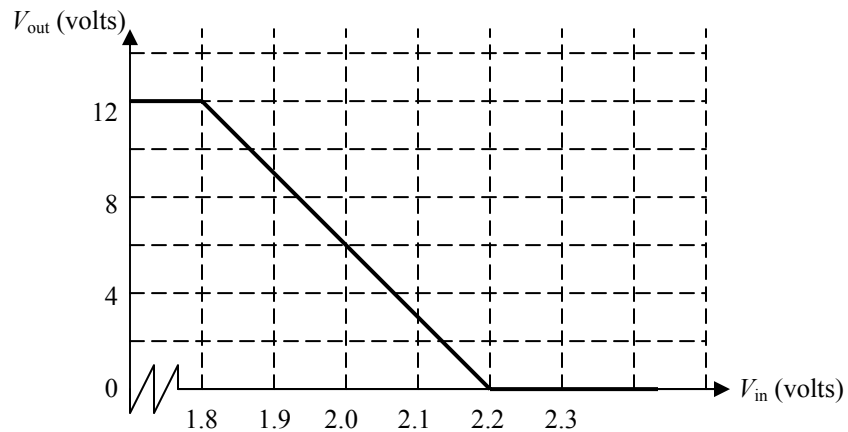
**Question 3**

Refer to the original circuit. If there is a short circuit across the  $750\ \Omega$  resistor, which one of the following statements is correct?

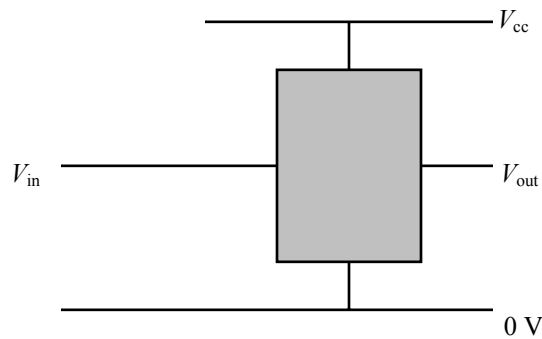
2 marks

- A. The voltage across the LED will be significantly higher.
- B. The voltage across the LED will be significantly lower.
- C. The voltage across the LED will **not** change significantly.
- D. The LED will be damaged by a stronger current.

The following graph shows the operational characteristics of a single stage npn transistor amplifier.



The rectangle in the following circuit diagram represents the single stage npn transistor amplifier.



**Question 4**

Calculate the signed voltage gain of the amplifier.

2 marks

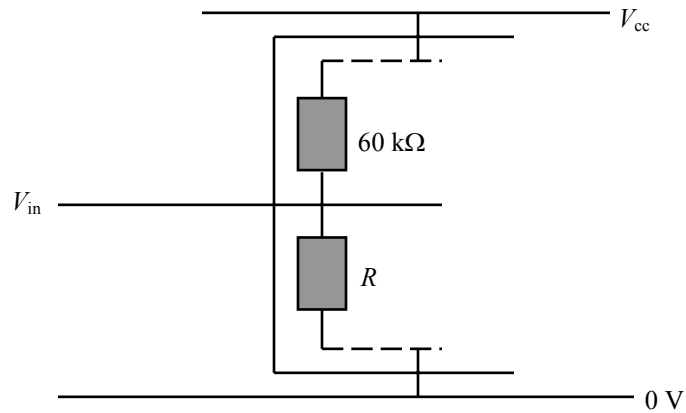
**Question 5**

Complete the following table.

3 marks

Value of $V_{cc}$	volts
Value of maximum peak-to-peak input signal without causing clipping of the output signal	volts
$V_{out}$ at saturation	volts

Inside the amplifier is a voltage divider for correct biasing of the base voltage of the npn transistor.



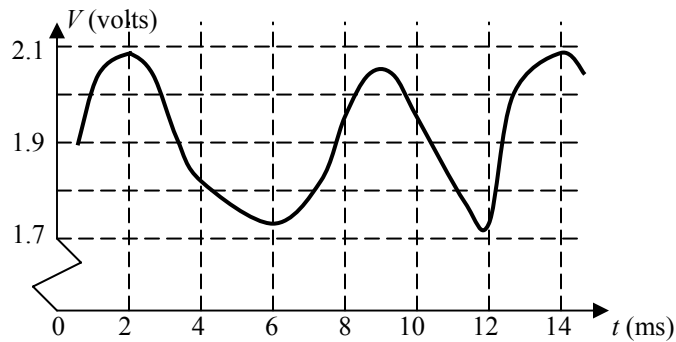
**Question 6**

Calculate the resistance of  $R$ .

3 marks

kΩ

A signal to be amplified is shown in the following graph.

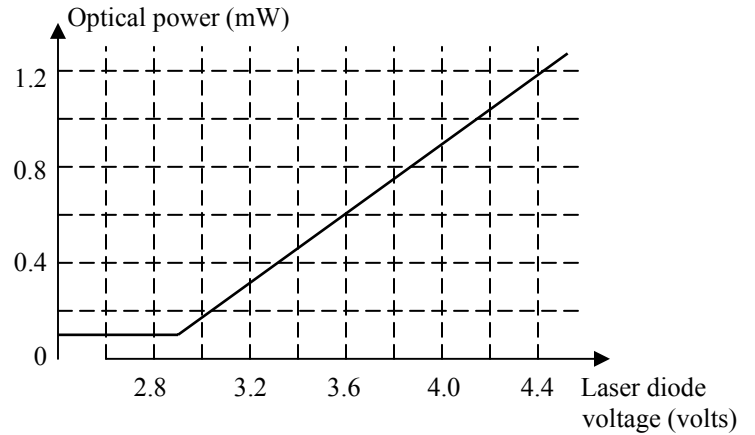
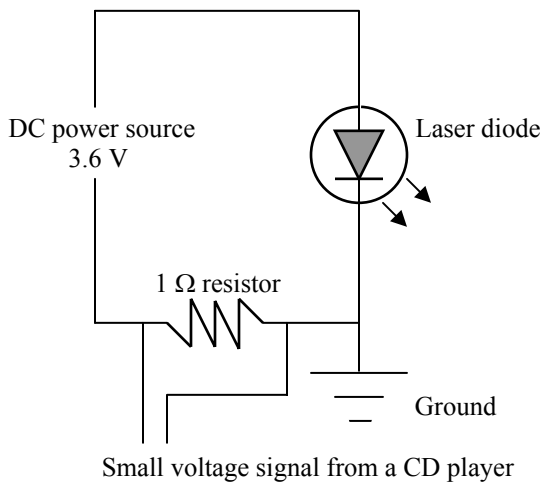


**Question 7**

What has to be done to ensure that the signal is centred at the linear-operating range of the amplifier to prevent clipping of the signal?

3 marks

The following is a schematic diagram of a simple opto-electronic converter. This device sends out information in analogue form using intensity modulated light. The accompanying graph shows the optical power output of the laser diode at different voltages.



### Question 8

Explain the meaning of ‘*This device sends out information in analogue form using intensity modulated light*’, especially the highlighted terms, in the introduction.

3 marks

### Question 9

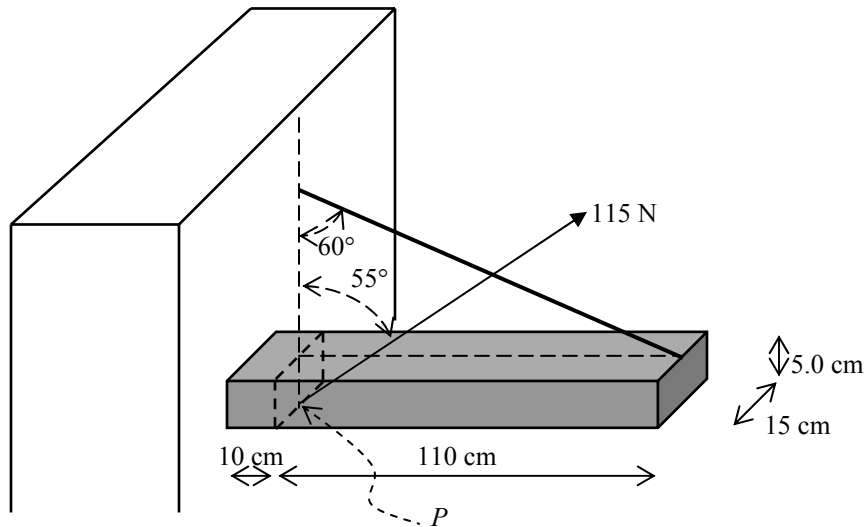
Signal from the CD player causes a change in voltage across the laser diode by  $\pm 0.10$  volts. Determine the variation in the optical power output of the laser diode.

3 marks

$\pm$   mW

## Detailed study 2 – Investigating materials and their use in structures

A uniform wooden plank is held in horizontal position by having one end embedded in a wall and the other end by a cable. There is a reaction force of 115 N from the wall on the plank at  $55^\circ$  to the vertical. Take  $g = 10 \text{ N kg}^{-1}$ . See the diagram below for other data.



### Question 1

Calculate the compressive stress and the shear stress at point  $P$ .

4 marks

Compressive	$\text{Nm}^{-2}$	Shear	$\text{Nm}^{-2}$
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### Question 2

Calculate the tension in the cable.

2 marks

### Question 3

Calculate the mass of the wooden plank.

2 marks

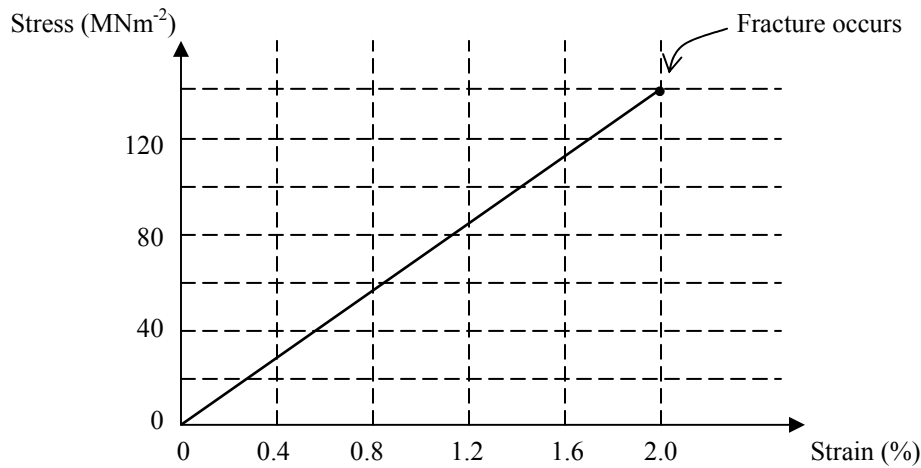
**Question 4**

What is the net torque on the wooden plank about point  $P$ ?

2 marks

Nm

A sample of ordinary glass is tested under tension until it fractures. The stress-strain graph is shown below.

**Question 5**

Complete the table below.

3 marks

<b>Tensile strength</b>	MNm <sup>-2</sup>
<b>Young's modulus</b>	MNm <sup>-2</sup>
<b>Strain energy</b>	MJm <sup>-3</sup>

**Question 6**

State a feature of the stress-strain graph above that indicates brittleness of ordinary glass.

1 mark

**Question 7**

Which one of the following properties is **common** for diamond, ordinary glass and table jelly?

2 marks

- A. Tough
- B. Brittle
- C. Plastic
- D. Stiff
- E. Strong

Car windscreen is toughened glass. It is made by chilling the hot glass by means of air jets until the outside is hardened while the inside is still soft.

**Question 8**

Explain how the manufacturing process toughens the glass in terms of tension and compression.

4 marks

Fibre-glass is a composite material consisting of glass and resin. Both resin and ordinary glass are brittle materials but fibre-glass is much tougher. A particular type of fibre-glass (e.g. fibre-glass fishing rods) has a tensile strength of  $1000 \text{ MNm}^{-2}$  and Young's modulus of  $35000 \text{ MNm}^{-2}$ .

**Question 9**

Calculate the resulting strain when a tensile stress of  $2.1 \text{ MNm}^{-2}$  is exerted on the particular type of fibre glass.

2 marks

%

**Question 10**

Explain why the composite material fibre-glass is much tougher than the component materials.

3 marks