itute.com

Online & home tutors **Registered business name: itute ABN: 96 297 924 083**

PHYSICS

2009

Trial Examination 1

Motion in one and two dimensions
Electronics and photonics
Materials and their use in structures

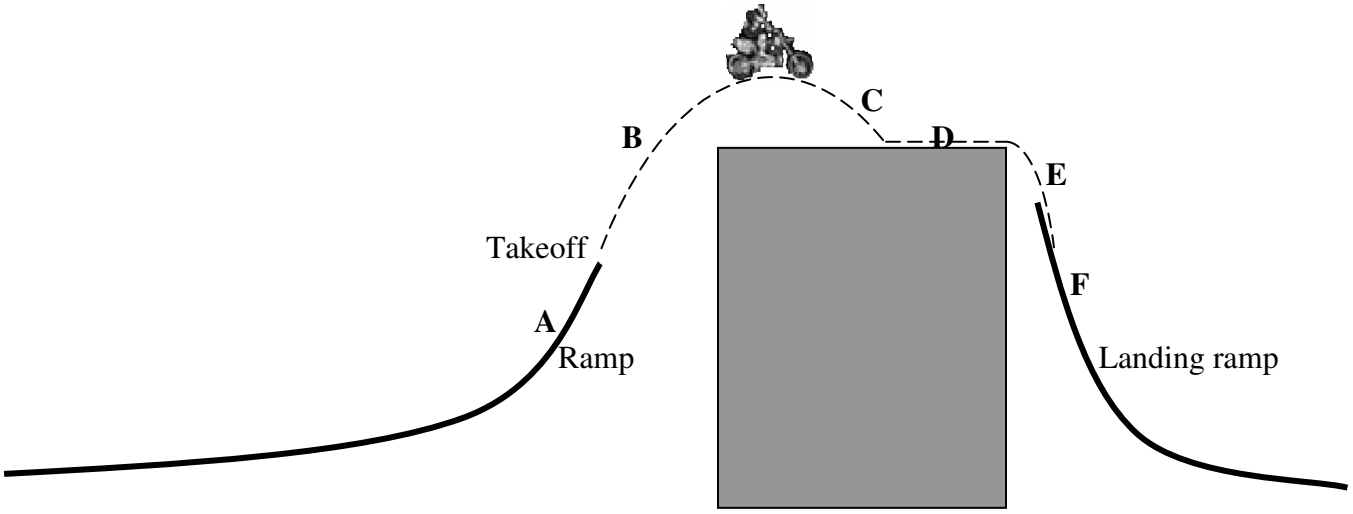
(Note: Use information in the formula data sheet supplied by VCAA)

Area of study 1 – Motion in one and two dimensions

Use the following information to answer Questions 1, 2 and 3.

The Australian stuntman Robbie Maddison rode into the new year with a gravity-defying feat in Las Vegas.

Speeding down the strip outside Paris Las Vegas casino, he launched his Yamaha motocross bike up a giant ramp. At takeoff the velocity was estimated to be 90 km h^{-1} at 80° with the horizontal. He flew through the air and landed on top of a replica of the Arc de Triomphe.



(***Not to scale***) Replica of the Arc de Triomphe

After landing safely, he took his death-defying stunt further by dropping off the Arc de Triomphe and falling 15 metres onto a landing ramp below. Assume zero air resistance.

Question 1
Calculate the speed at takeoff in ms^{-1}.

1 mark

Question 2
Calculate the maximum height reached in metres above the takeoff point.

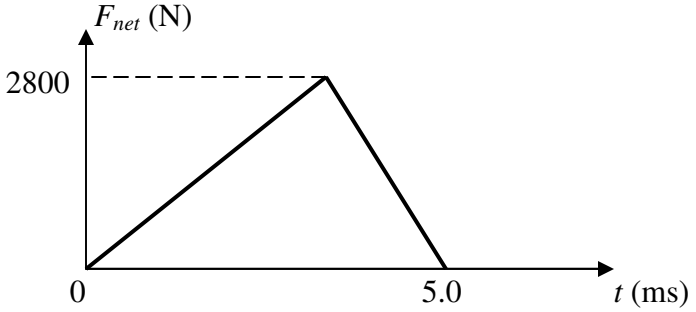
2 marks

Question 3
Different sections of the path are labeled as **A**, **B**, **C**, **D**, **E** and **F** as shown in the diagram above. In which one (or more) was the bike in free fall?

2 marks

Use the following information to answer Questions 4 and 5

The graph shows the changing magnitude of a net force over a 5.0 ms interval causing a cricket ball to displace by 1.5 cm in the same direction as the net force.



Question 4
Calculate the magnitude of the change in momentum (in kg ms^{-1}) of the cricket ball in the 5.0 ms interval.

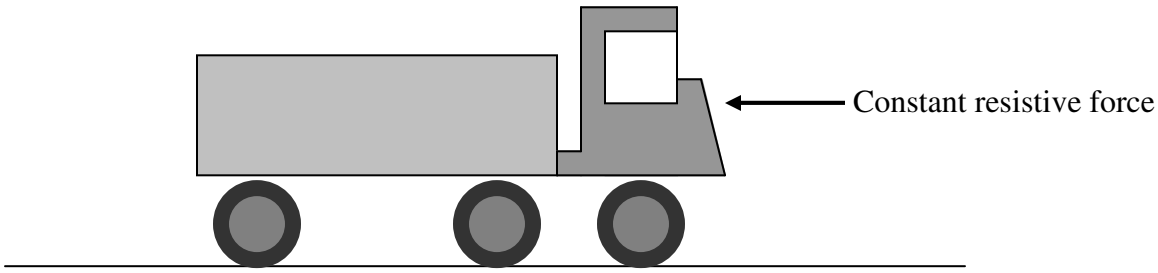
2 marks

Question 5
Calculate the change in kinetic energy of the cricket ball in the 5.0 ms interval.

2 marks

Use the following information to answer Questions 6, 7, 8 and 9

A water tanker travels in a straight highway at **full** speed of 30 ms^{-1}. There is a **constant** resistive force of 5200 N in total against the motion of the tanker. Assume the motor drives the front wheels **only**.



Question 6
Using the length of the arrow (shown in the diagram above) representing the constant resistive force as the reference, draw an arrow to represent the force of the road on the rear wheels due to friction.

2 marks

Question 7
Using the length of the arrow (shown in the diagram above) representing the constant resistive force as the reference, draw an arrow to represent the force of the road on the front wheels due to friction.

2 marks

Question 8
Calculate the amount of work done in a minute by the motor against the resistive force.

J

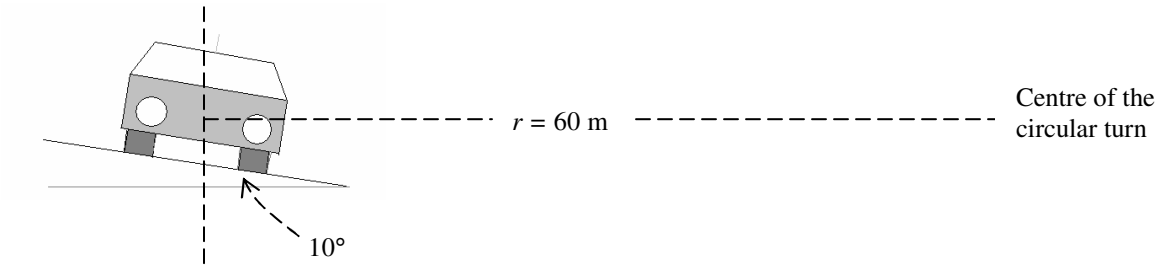
2 marks

Question 9
After travelling at full speed of 30 ms^{-1} for a while, large volume of water starts to leak out continuously from the tank while the tanker is in motion. Describe and explain the motion of the tanker from the moment the leak starts.

3 marks

Use the following information to answer Questions 10, 11, 12 and 13

A 1200-kg car enters a circular turn whose radius is 60 m. The road is banked at an angle of 10°. The maximum friction force between the tyres and the road surface is 0.6 times the normal force of the road on the car.



Question 10
On the diagram above draw an accurate arrow to show the direction of (a) the normal force $\vec{N}$ of the road on the car, (b) the weight $\vec{W}$ of the car, and (c) the force $\vec{F}_f$ of the road on the car due to friction. Label each arrow.

2 marks

Question 11
On the diagram above draw and label an arrow to show the direction of the net force $\vec{F}_{net}$ on the car.

1 mark

Question 12
Calculate the net force on the car at a speed of 15 ms^{-1}.

	N

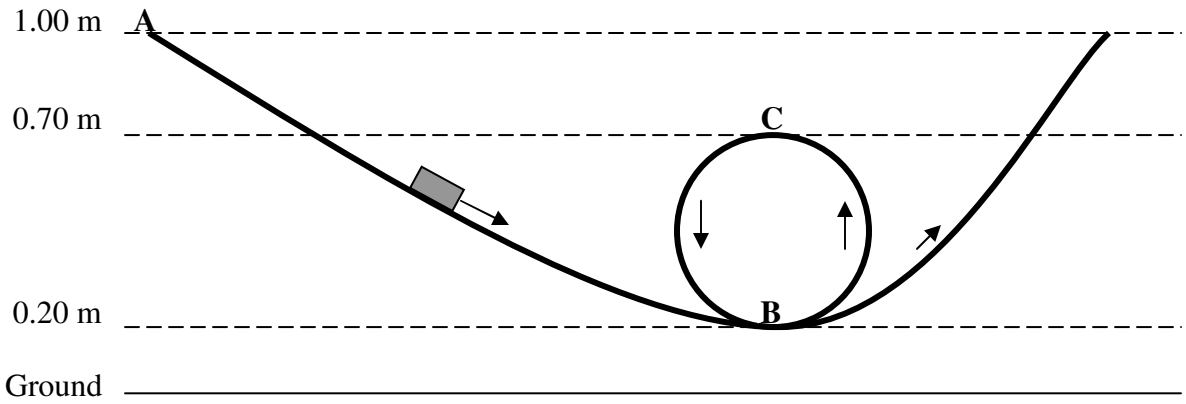
2 marks

Question 13
State the benefits of a banked road to motorists making a turn.

2 marks

Use the following information to answer Questions 14 and 15

A toy car of mass 110 grams rolls down an inclined track with a vertical loop (circular, radius 0.25 m) at the bottom as shown in the following diagram. The toy car starts from rest at point **A**. Ignore air resistance and friction.



Question 14
Calculate **apparent** weight of the toy car at point **C**.

	N

3 marks

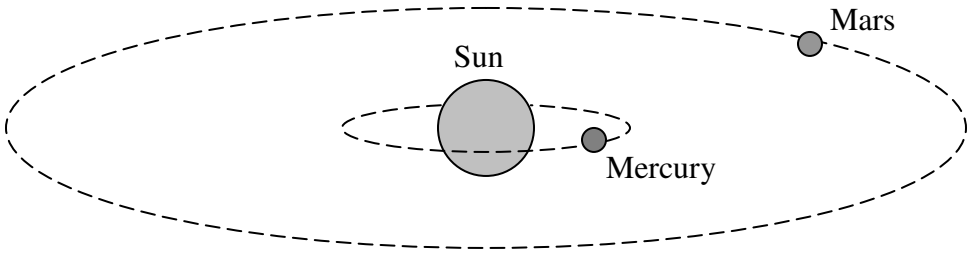
Question 15
Calculate the impulse received by the toy car when it moves from point **B** to point **C**.

3 marks

	Ns

Use the following information to answer Questions 16, 17 and 18

The distance of Mars from the sun is approximately 4 times the distance of Mercury from the sun. The gravitational field strength of the sun (mass = 2.0×10^{30} kg) at the orbit of Mars is 2.57×10^{-3} N kg^{-1}.



Question 16
What is the magnitude of the centripetal acceleration of Mars?

ms^{-2}

2 marks

Question 17
Estimate the gravitational field strength of the sun at the orbit of Mercury.

N kg^{-1}

2 marks

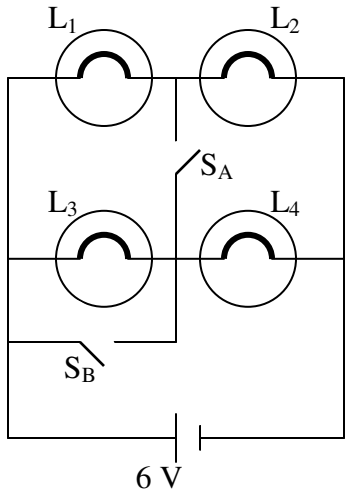
Question 18
Determine the value of $\frac{(T_{Mercury})^2}{(r_{Mercury})^3}$, where $T_{Mercury}$ is the period (in seconds) of Mercury around the sun, and $r_{Mercury}$ (in metres) is the mean radius of the orbit of Mercury. Include units in your answer.

3 marks

Area of study 2 – Electronics and photonics

Use the following information to answer Questions 1, 2 and 3

In the following circuit there are four identical light globes L_1, L_2, L_3 and L_4, each rated 1.5 W 3.0 V. **Initially** the two on/off switches S_A and S_B are **off**.



Question 1
Calculate the effective resistance of the circuit consisting of L_1, L_2, L_3 and L_4.

2 marks

Question 2
Describe and explain how the brightness of each light globe will be affected if only S_A is switched **on**.

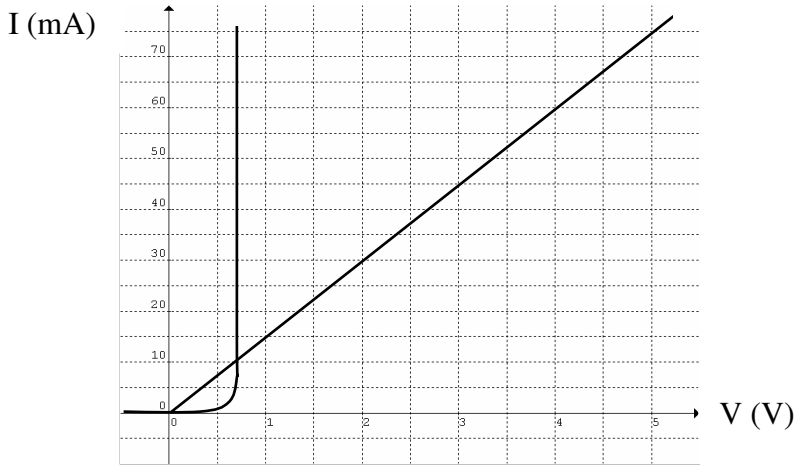
2 marks

Question 3
Describe and explain the effects on the light globes if only S_B is switched **on**.

3 marks

Use the following information to answer Questions 4 and 5

The current-voltage characteristics of a diode and a resistor are shown together in the diagram below.



The diode and the resistor are connected in series with a DC power supply. The switch-on voltage of the diode is 0.70 V and there is a current of 75 mA through the resistor.

Question 4
Determine the voltage of the power supply.

V

2 marks

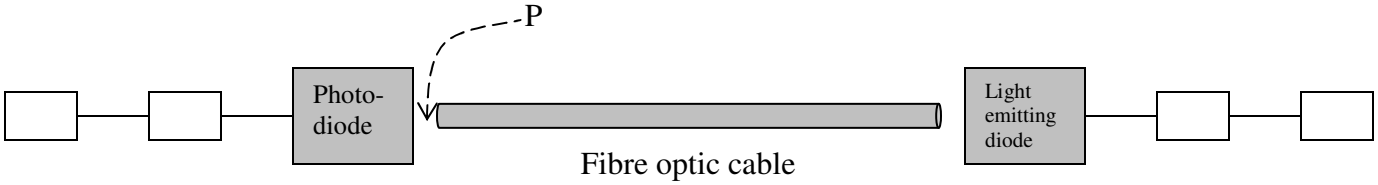
Question 5
Determine the resistance of the diode.

Ω

2 marks

Use the following information to answer Questions 6 and 7

The following schematic diagram shows an over-simplified analog communication system using light intensity modulation and demodulation.

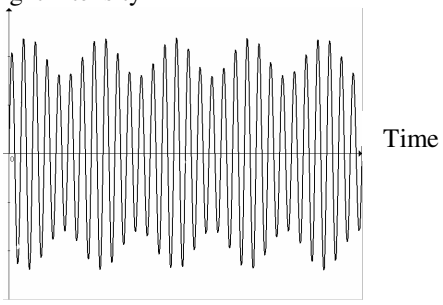


Question 6
In the boxes shown above write M for modulator, D for demodulator, O for output signals and I for input signals.

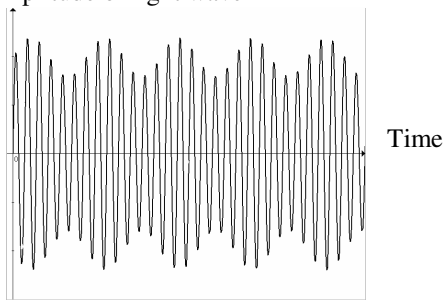
2 marks

Question 7
Which **one or more** of the following graphs best represent the signal at point P when there is a single-frequency signal sent through the system?

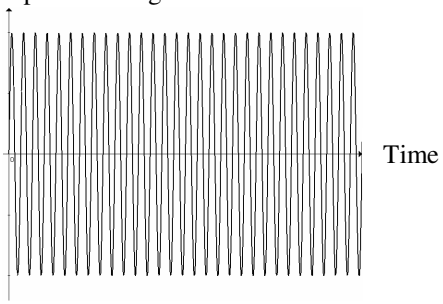
A. Light intensity



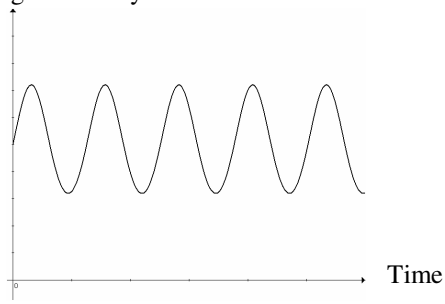
B. Amplitude of light wave



C. Amplitude of light wave



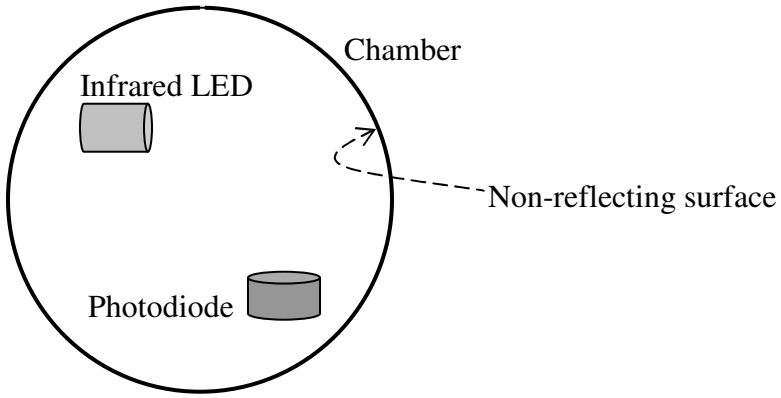
D. Light intensity



2 marks

Use the following information to answer Questions 8 and 9

The following diagram shows the arrangement of the photonic parts of a photoelectric smoke detector.

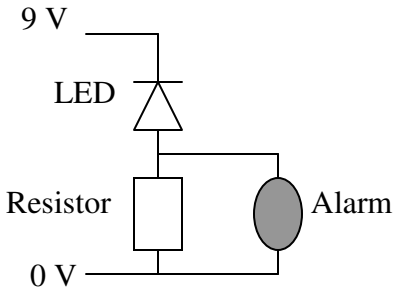


Question 8
Describe and explain the working of the photonic parts of the detector in triggering the alarm (not shown) when smoke enters the chamber.

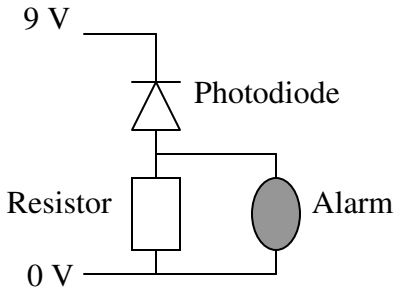
3 marks

Question 9
Which one of the following shows the correct connection of the alarm?

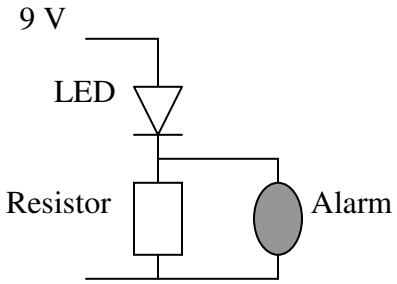
A.



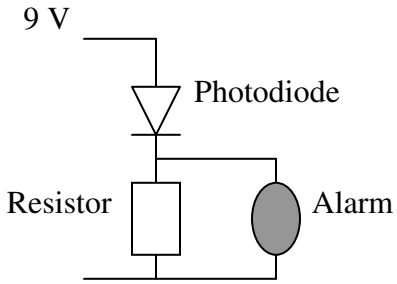
B.



C.



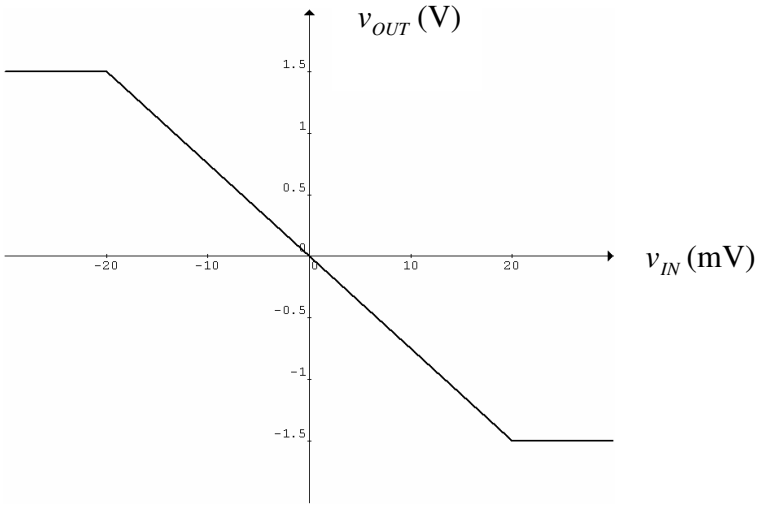
D.



2 marks

Use the following information to answer Questions 10, 11 and 12

A simplified voltage-transfer characteristic of a voltage amplifier is shown in the following graph.



Question 10
Determine the voltage gain of the amplifier.

2 marks

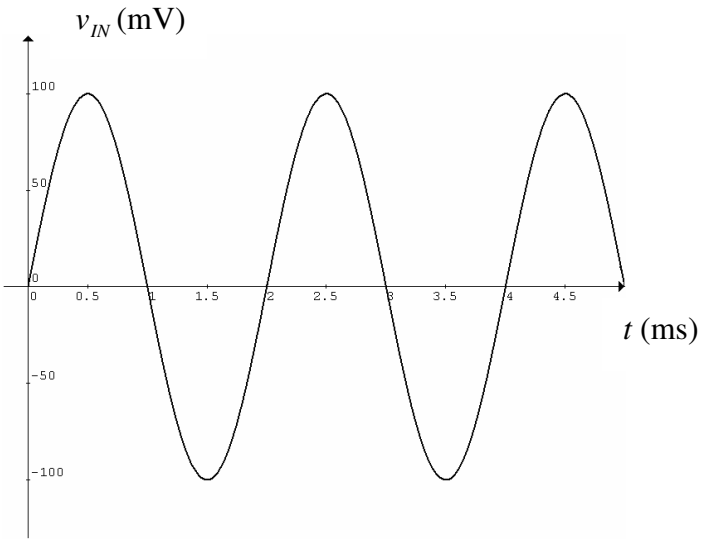
Question 11
What is the maximum peak-to-peak voltage of the output signal if the peak-to-peak voltage of the input signal is 25 mV?

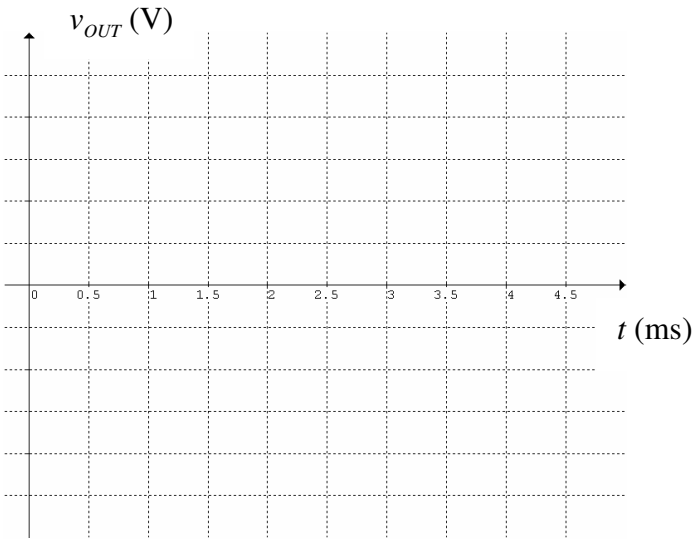
	V

1 mark

Question 12
The graph of v_{IN} versus time t is shown below. Sketch the graph of v_{OUT} versus t on the grid provided. **Scale the vertical axis**.

3 marks





Detailed study 2 – Materials and their use in structures

Multiple-choice questions: Choose the **best** answer for each question. Write the letter of your choice in each answer box.

Question 1
Compressive stress in a loaded uniform concrete column has

A. a maximum value at the top.

B. a maximum value at the bottom.

C. a maximum value in the middle.

D. the same value at any height.

2 marks

Question 2
The tyres (parts in contact with the ground) of a truck while braking experience

A. only tensile stress and compressive stress.

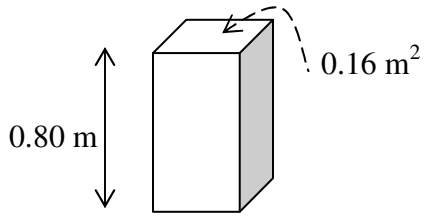
B. only tensile stress and shear stress.

C. only compressive stress and shear stress.

D. only compressive stress.

2 marks

Use the following information to answer Questions 3 and 4



The **square** base of a 0.80 m tall rectangular prism has an area of 0.16 m^2. It is made to lean to one side at an angle.

Question 3
At the exact moment when the prism is on the verge of toppling over, on the prism

A. the net torque is zero and the net force is also zero.

B. the net torque is greater than zero and the net force is negative.

C. the net torque is greater than zero and the net force is also greater than zero.

D. the net torque is negative and the net force is greater than zero.

2 marks

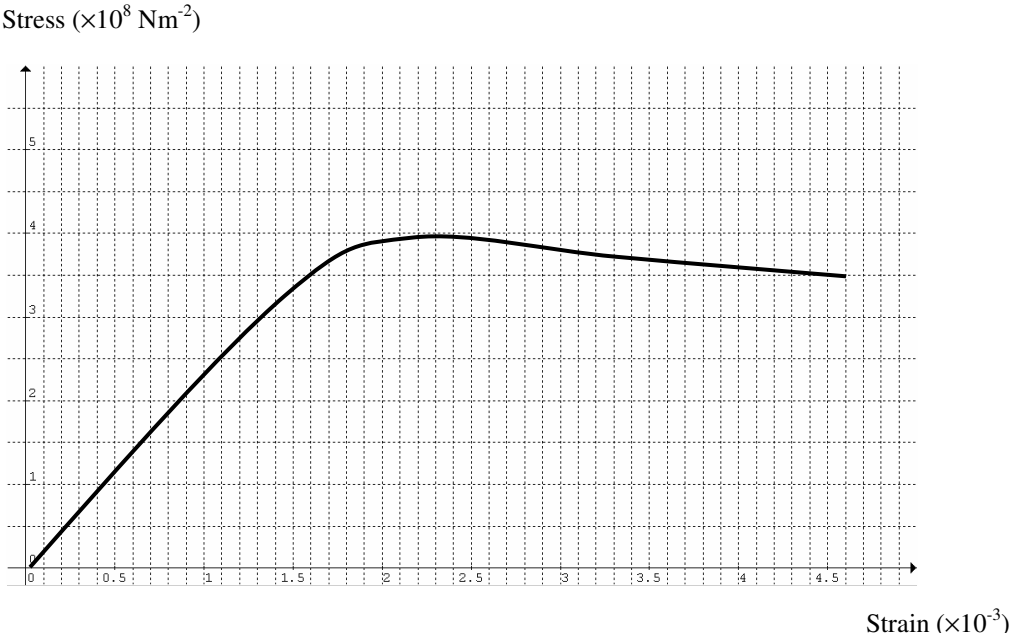
Question 4
The maximum leaning angle (whole number of degrees measured from the vertical) of the prism before it topples over is

A. 11° B. 12° C. 26° D. 27°

2 marks

Use the following information to answer Questions 5, 6 and 7

The stress-strain graph of a material stretched up to the point of failure is shown below.



Question 5

The tensile strength and elastic limit of the material are respectively

A. 4.0×10^{8} Nm^{-2} and 3.0×10^{8} Nm^{-2}

B. 3.5×10^{8} Nm^{-2} and 3.0×10^{8} Nm^{-2}

C. 3.5×10^{8} Nm^{-2} and 3.5×10^{8} Nm^{-2}

D. 3.5×10^{8} Nm^{-2} and 4.0×10^{8} Nm^{-2}

2 marks

Question 6

The total amount of energy absorbed by 1.0 cm^3 of the material when it is loaded to the point of failure is closest to

A. 0.15 J B. 1.5 J C. 15 J D. 150 J

2 marks

Question 7
When the material is loaded to a stress of 3.8×10^{8} Nm^{-2},

A. the material fractures.

B. the length of the material increases by 1.8%.

C. the length of the material increases by 0.18%.

D. the length of the material increases by 0.0018%.

2 marks

Use the following information to answer Questions 8 and 9

Material	**Young's modulus** (GPa)	**Elastic limit** (MPa)	**Tensile strength** (MPa)	**Compressive strength** (MPa)
M_1	200	450	800	600
M_2	18	4	4	20
M_3	70	100	100	100
M_4	15	35	40	35

Four different materials are labelled as M_1 , M_2 , M_3 and M_4.

Question 8
The **brittle** material with the greatest stiffness is

A. M_1 B. M_2 C. M_3 D. M_4

2 marks

Question 9
For material M_1 a strain that can cause permanent deformation without breaking is

A. greater than 4.9×10^{-3}

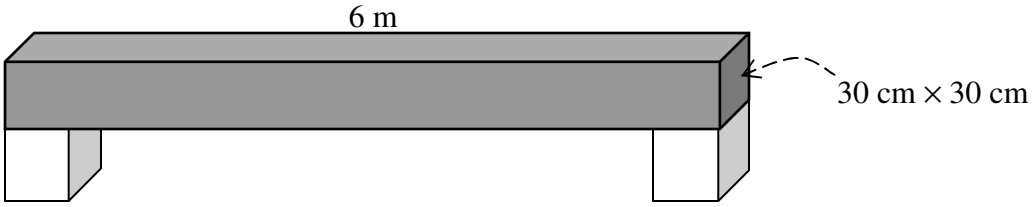
B. less than 1.5×10^{-3}

C. between 2.3×10^{-3} and 2.9×10^{-3}

D. between 2.9×10^{-3} and 3.9×10^{-3}

2 marks

Question 10



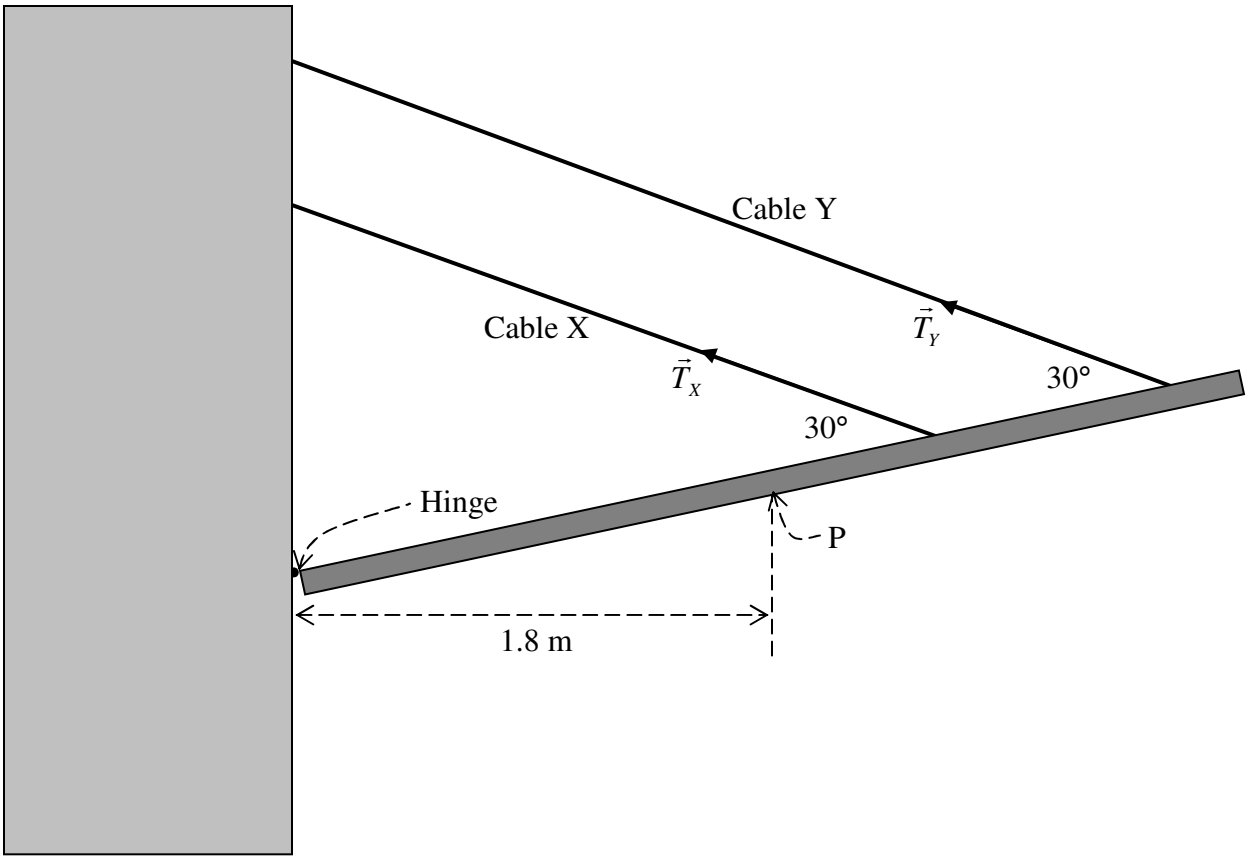
Among the four materials (shown below) the most suitable and economical one for building the load bearing horizontal beam (shown above) is

A. bricks and mortar B. concrete C. steel D. pre-stressed concrete

2 marks

Use the following information to answer Questions 11, 12 and 13

Two cables keep a 75-kg plank in equilibrium. The centre of mass of the plank is at point P. The tensions in cable X and cable Y are $\vec{T}_X$ and $\vec{T}_Y$ respectively. **The reaction force of the hinge on the plank is** $\vec{R}$.



Question 11
The **sum** of $\vec{T}_X$, $\vec{T}_Y$ and $\vec{R}$ on the plank is

A. zero.

B. less than 700 N upward.

C. less than 700 N downward.

D. greater than 700 N upward.

2 marks

Question 12
The **sum** of the torques of $\vec{T}_X$, $\vec{T}_Y$ and $\vec{R}$ on the plank about the hinge is

A. zero.

B. 1350 Nm in the anticlockwise direction.

C. less than 1200 Nm in the clockwise direction.

D. not determinable.

2 marks

Question 13
Which one of the following statements is true?

A. $T_Y = T_X$

B. $T_Y > T_X$

C. $T_Y < T_X$

D. Insufficient given information to determine the relative magnitudes of $\vec{T}_X$ and $\vec{T}_Y$.

2 marks

End of Trial Exam 1