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PHYSICS

2012

Trial Examination 1

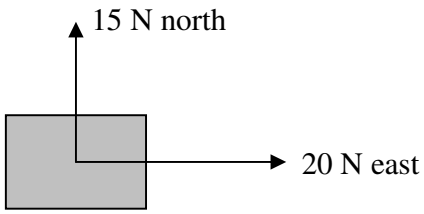
Motion in one and two dimensions
Electronics and photonics
Materials and their use in structures

(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.

A 10 kg box remains at rest on a rough floor when it is pulled by two forces 15 N north and 20 N east.



Question 1 Calculate the force exerted by the floor on the box due to friction.

Magnitude: N	Direction:

2 marks

Question 2 Calculate the magnitude of the reaction force of the floor on the box.

N

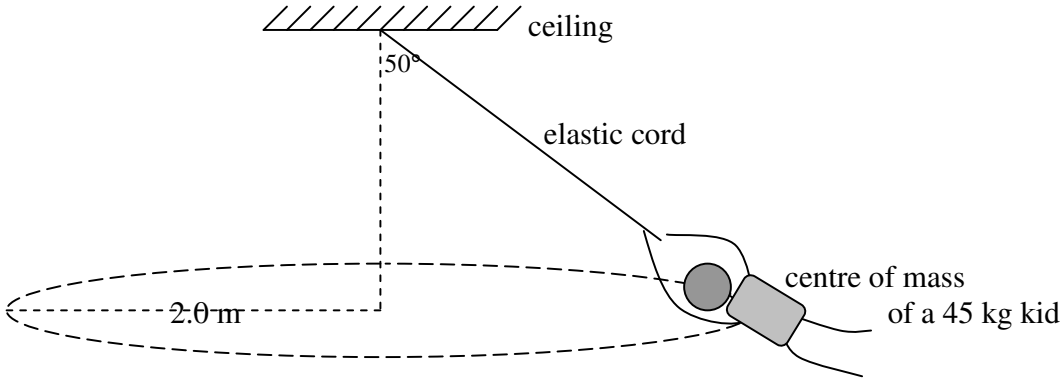
2 marks

Question 3 The box begins to slide with an acceleration of 1.5 m s^{-2} when the two forces are doubled in magnitude. Calculate the sliding friction between the box and the floor.

N

2 marks

Use the following information to answer Questions 4, 5 and 6



The 45 kg kid is made to go around in a horizontal circle of 2.0 m radius (measured from the centre of mass of the kid) by holding onto an elastic cord. The cord is extended by 20 cm and makes a 50° angle with the vertical.

Question 4 Determine the force constant (spring constant) of the elastic cord.

N m^{-1}	2 marks

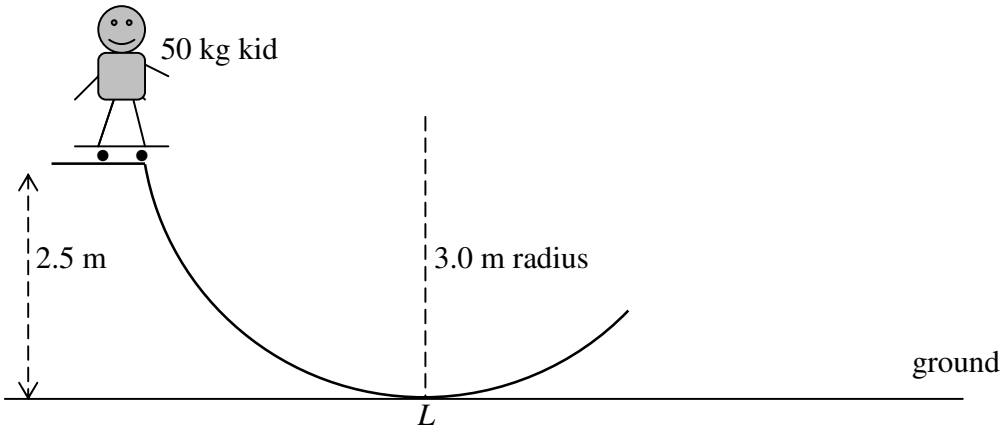
Question 5 Determine the magnitude of the kid's acceleration.

m s^{-2}	2 marks

Question 6 Determine the speed of the kid.

m s^{-1}	2 marks

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



A 50 kg kid rides on a skateboard down a circular trough of radius 3.0 m from a height of 2.5 m above the lowest point *L*. The kid starts from rest. Assume that air resistance and friction are insignificant.

Question 7 Calculate the speed of the kid at the lowest point *L*.

m s^{-1}	2 marks

Question 8 Calculate the apparent weight of the kid when he passes through point *L*.

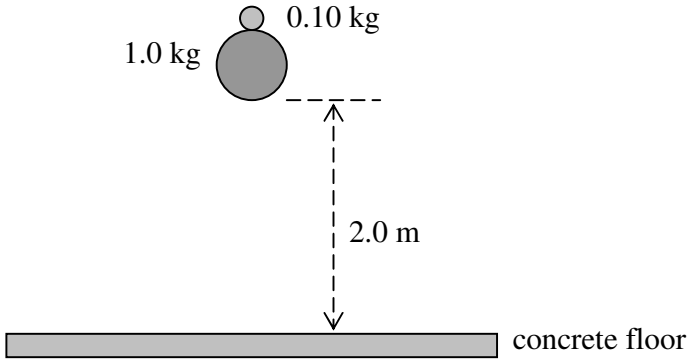
N	2 marks

Question 9 Determine the speed of landing on the ground.

m s^{-1}	1 mark

Use the following information to answer Questions 10, 11, 12, 13 and 14

A small ball (0.10 kg) is on top of a large ball (1.0 kg), and they are dropped from a height of 2.0 m above a concrete floor.
The large ball is in contact with the floor for 0.020 s and the two balls are together with the small one on top of the large one.
At the moment of taking off the small ball moves upwards with a speed of 6.0 m s^{-1} whilst the large ball moves upwards with a speed of 4.0 m s^{-1}.
All motions are vertical and air resistance is insignificant.



Question 10 Determine the reaction force of the large ball on the small ball while they are falling.

	N

1 mark

Question 11 Calculate the speed of the large ball just before it hits the floor.

	m s^{-1}

2 marks

Question 12 Calculate the common speed of the two balls immediately before taking off.

	m s^{-1}

2 marks

Question 13 Calculate the magnitude of the net impulse acting on the balls in the interval when the large ball is in contact with the concrete floor.

N s

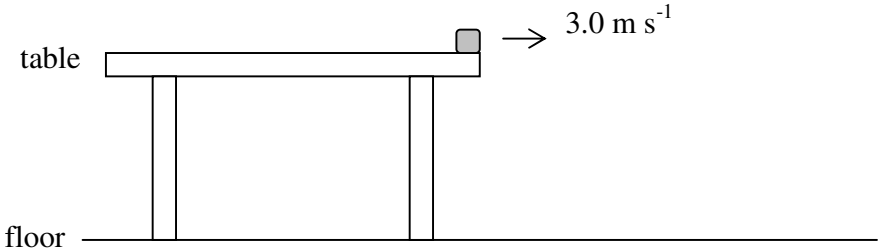
3 marks

Question 14 Calculate the magnitude of the average net force $F_{average}$ on the balls in the interval when the large ball is in contact with the concrete floor.

N

2 marks

Use the following information to answer Questions 15 and 16



A block slides off a horizontal table at 3.0 m s^{-1} and the speed increases to 5.0 m s^{-1} just before it hits the floor. Consider the block as a point mass. Air resistance is insignificant.

Question 15 Calculate the time of flight of the block.

s

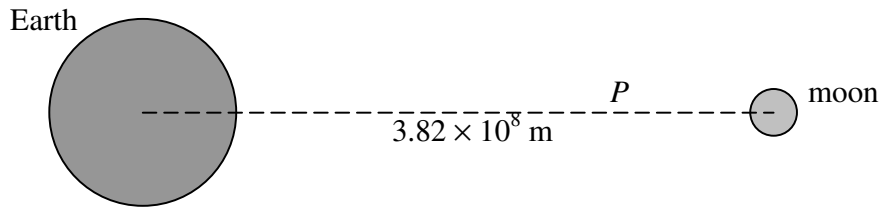
3 marks

Question 16 Calculate the magnitude of the block's displacement during its flight.

m	3 marks

Use the following information to answer Questions 17, 18, 19 and 20

The average distance between Earth and the moon is 3.82×10^8 m. Assume that the moon orbits around Earth once every 27 days.



Question 17 There is a point *P* between Earth (5.98×10^{24} kg) and the moon (7.36×10^{22} kg) where there is zero net gravitational field due to these two bodies only.

Determine the value (nearest whole number) of the ratio $\frac{PE}{Pm}$, where PE is the distance of *P* from Earth's centre and Pm is the distance of *P* from the moon's centre.

	2 marks

Question 18 Hence find the distance PE.

m	1 mark

Question 19 Calculate the exact value of the ratio $\frac{T_{moon}}{T_{gs}}$, where T_{moon} is the orbital period of the moon around Earth, and T_{gs} is the orbital period of a geostationary satellite.

1 mark

Question 20 Hence find the orbital radius of a geostationary satellite.

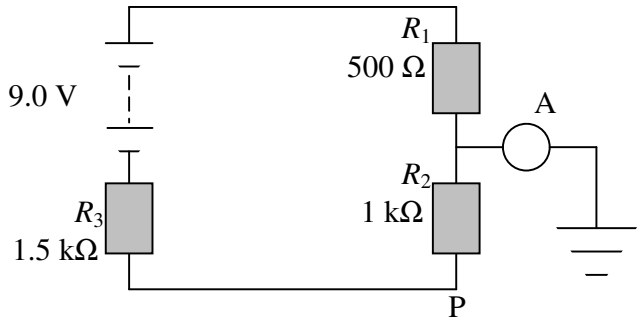
m

3 marks

Area of study 2 – Electronics and photonics

Use the following information to answer Questions 1, 2, 3 and 4

The following circuit consists of a battery supplying a constant voltage of 9.0 V, an ammeter A, and three ohmic resistors R_1, R_2 and R_3.



connected to the ground

Question 1 What is the voltage drop across R_1?

V

2 marks

Question 2 What is the electric current reading of ammeter A?

mA

1 mark

Question 3 Determine the electric potential at point P.

V

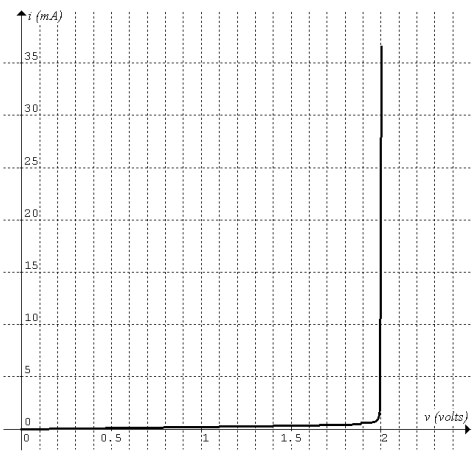
2 marks

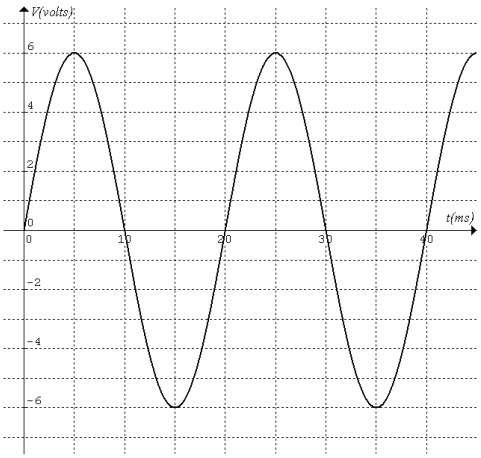
Question 4 Determine the value of the ratio $\frac{P_3}{P_1}$, where P_1 and P_3 are the electric powers dissipated in R_1 and R_3 respectively.

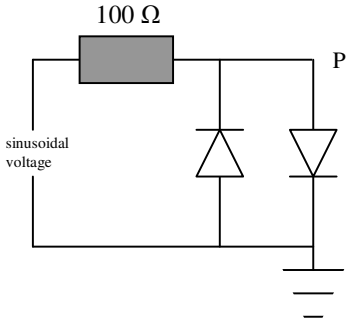
2 marks

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

The following graphs show the *i*-*v* characteristics of a LED and a sinusoidal voltage supply. A student connects two such LED's and a 100 Ω resistor to the sinusoidal voltage (6 V amplitude). The circuit is shown below.





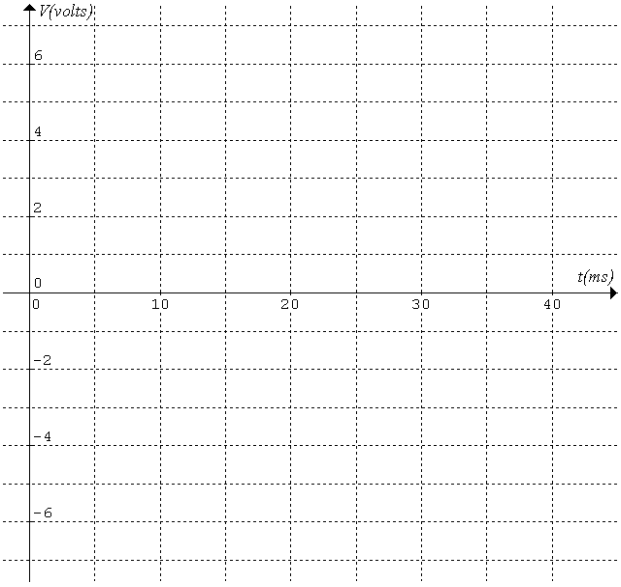


Question 5 Determine the highest current through the 100 Ω resistor.

mA

2 marks

Question 6 Sketch accurately the voltage at point P .



3 marks

Question 7 Now one of the LED's in the circuit is rewired. Which one of the following statements gives the best description of the new situation?

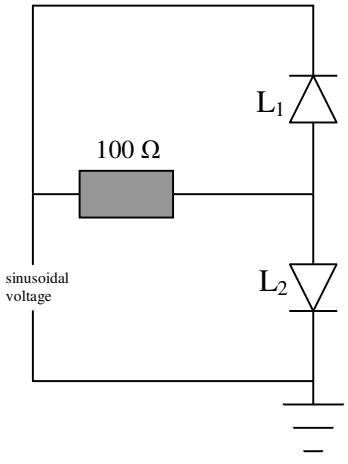
A. Both L_1 and L_2 go on and off simultaneously.

B. When L_1 is on, L_2 is off and vice versa.

C. L_2 goes on and off, whilst L_1 is off.

D. L_1 goes on and off, whilst L_2 is off.

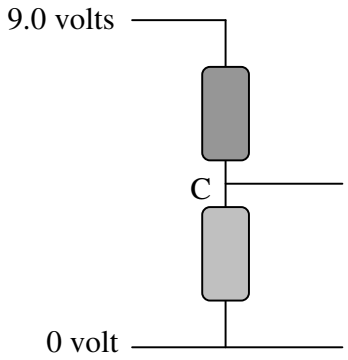
E. L_2 goes on and off, whilst L_1 remains on.



2 marks

Use the following information to answer Questions 8, 9 and 10

An non-contact switch consists of a LDR and a 5k Ω resistor connected in series with a 9.0 V constant power source. It will automatically turn on a neon sign when the potential at the connecting point C of the LDR and the resistor drops below 4.0 volts.



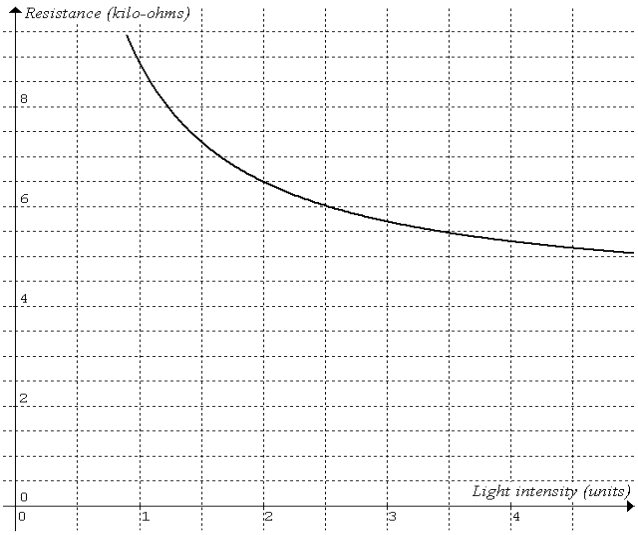
Question 8 On the diagram above, label the resistor with letter R. 2 marks

Question 9 Determine the resistance of the LDR when point C is at 4.0 volts.

	kΩ

2 marks

Question 10 The characteristic of the LDR is shown below. Find the range of light intensity that will keep the neon sign on.



	units

2 marks

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

Fig. 1 displays the **output signal** of a voltage amplifier when the input is a *sinusoidal* signal, and Fig. 2 shows the voltage transfer curve of the amplifier. The voltage gain of the amplifier is -20.

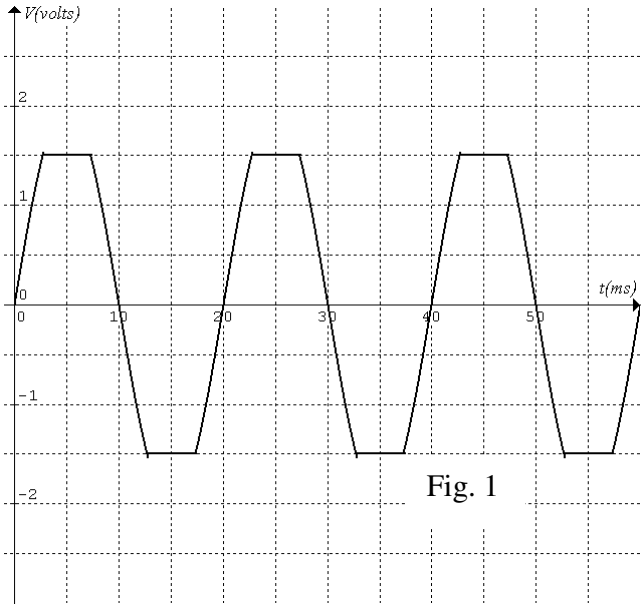


Fig. 1

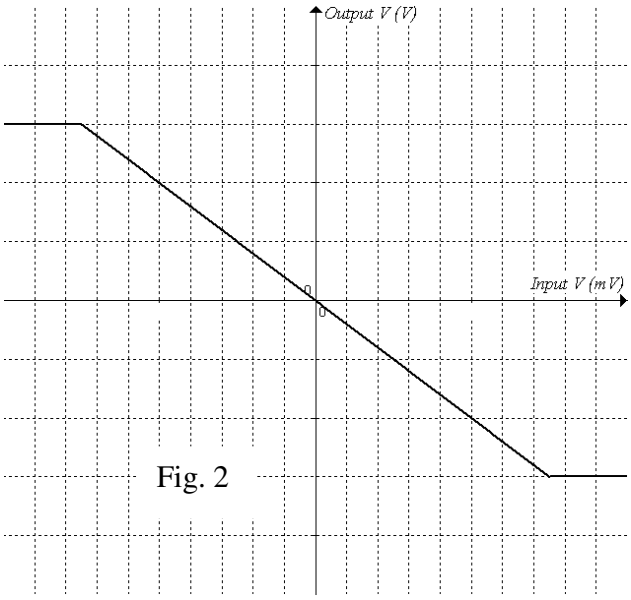


Fig. 2

Question 11 Determine the period of the input signal.

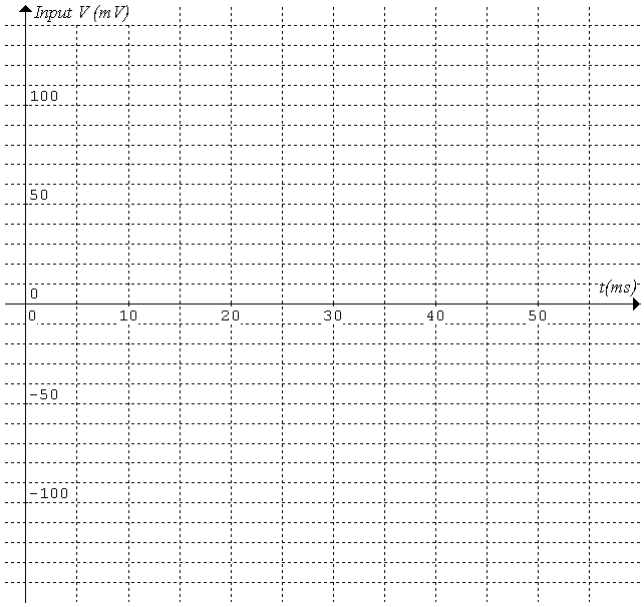
ms

1 mark

Question 12 Write correct scales on the vertical and horizontal axes in Fig. 2.

3 marks

Question 13 Sketch accurately the input signal voltage (mV) versus time (ms) in the following grid.



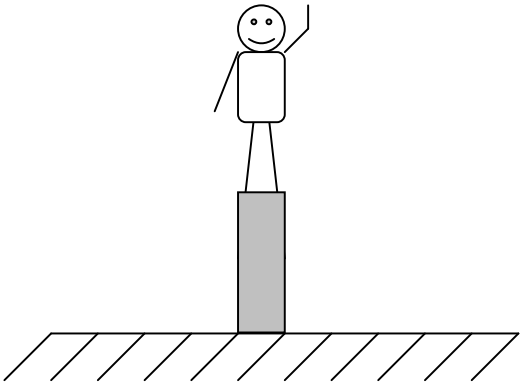
2 marks

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.

Use the following information to answer Questions 1 and 2

A 15 kg uniform cylindrical column has a radius of 5.0 cm with a 35 kg child standing on top of it.



Question 1 The compression in the column is

A. a constant value of 250 N
B. a constant value of 350 N
C. a constant value of 500 N
D. higher at the base of the column than at the top

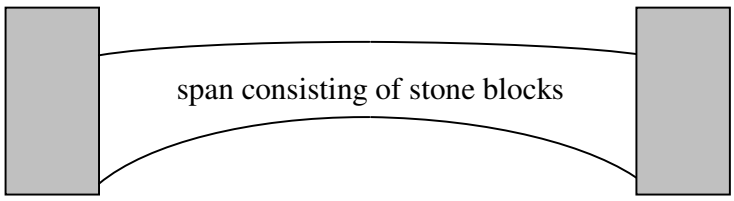
2 marks

Question 2 The compressive stress in the middle of the column is closest to

A. $4.5\ \text{N m}^{-2}$
B. $4.5\times10^{4}\ \text{N m}^{-2}$
C. $5.5\times10^{4}\ \text{N m}^{-2}$
D. $6.5\times10^{4}\ \text{N m}^{-2}$

2 marks

Question 3 The span of a bridge built with stone blocks has an arch underside.



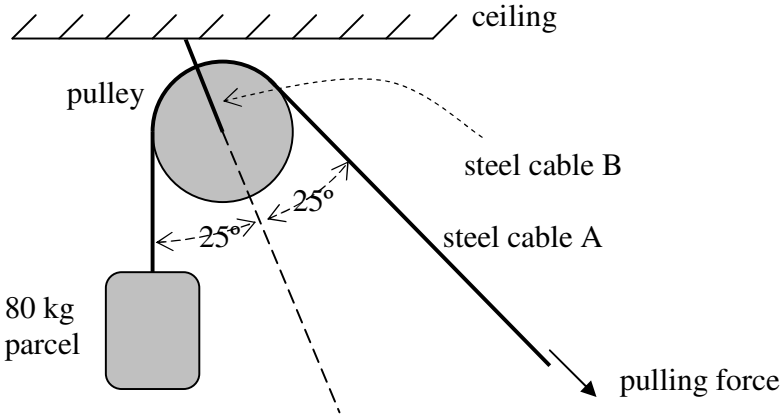
Choose the best description of the span.

A. The upper part is in tension whilst the lower part is in compression.
B. The upper part is in compression whilst the lower part is in tension.
C. The whole span is in compression.
D. The whole span is in tension.

2 marks

Use the following information to answer Questions 4, 5 and 6

A 80 kg parcel is lifted upwards at constant speed by means of a cable-pulley system. The steel cables A and B have the same radius of 5.0 mm and Young modulus of 200 GPa. The pulley is free to rotate. Consider the cables and pulley to have insignificant mass.



Question 4 The tension in steel cable A is closest to

A. 1600 N
B. 1450 N
C. 1200 N
D. 800N

2 marks

Question 5 The tension in steel cable B is closest to

A. 1600 N
B. 1450 N
C. 1200 N
D. 800N

2 marks

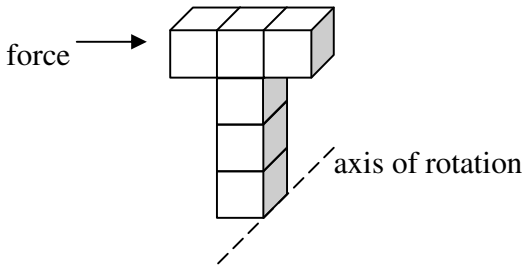
Question 6 The strain in steel cable B is closest to

A. 0.0001
B. 0.001
C. 0.01
D. 0.1

2 marks

Use the following information to answer Questions 7 and 8

Six cm cubes are securely glued together to form a T shape structure. The T shape structure stands upright on a rough horizontal surface. Each cube has a mass of 1 gram. A force is used to push the structure as shown in the diagram below.



Question 7 The maximum tilting angle before the structure topples over is closest to

A. 10°
B. 11°
C. 12°
D. 13°

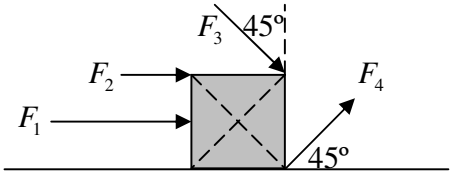
2 marks

Question 8 The cube on the extreme right exerts a torque on the structure. The magnitude of the torque about the axis of rotation is closest to

A. 5×10^{-6} N m
B. 1×10^{-5} N m
C. 5×10^{-5} N m
D. 1×10^{-4} N m

2 marks

Question 9 A 1.2 kg solid cube has a volume of 1000 cm^3. It is placed on a rough horizontal floor. The friction is sufficiently large to prevent the cube from sliding.
One force ($F_1 = 13\,\text{N},\ F_2 = 6\,\text{N},\ F_3 = 8\,\text{N}$ or $F_4 = 9\,\text{N}$) is applied on the cube as shown in the diagram below.



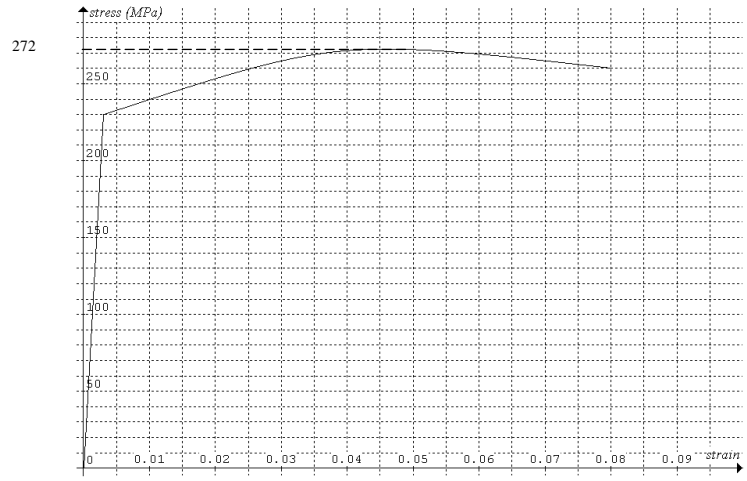
The force that can cause the cube to roll is

A. F_1 or F_4
B. F_2 or F_3
C. F_1 only
D. F_2 only

2 marks

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

The stress-strain graph for a material is shown below.



Question 10 The material is best described as

A. brittle
B. elastic
C. ductile
D. stiff

2 marks

Question 11 Young's modulus of the material is closest to

A. 8000 GPa
B. 800 MPa
C. 80 GPa
D. 8 MPa

2 marks

Question 12 The material

A. will fracture when stress increases to 260 MPa
B. will fracture when stress exceeds 272 MPa
C. will not fracture when stress reaches 272 MPa and remains at that value
D. will not fracture when stress reaches 272 MPa and reduces to zero immediately

2 marks

End of Trial Exam 1