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PHYSICS

2012

Trial Examination 1

Motion in one and two dimensions

Electronics and photonics

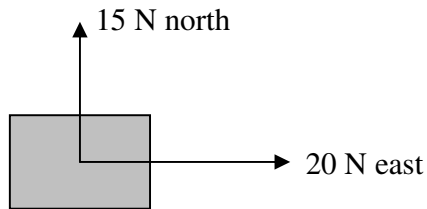
Materials and their use in structures

(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:
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2 marks

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

N

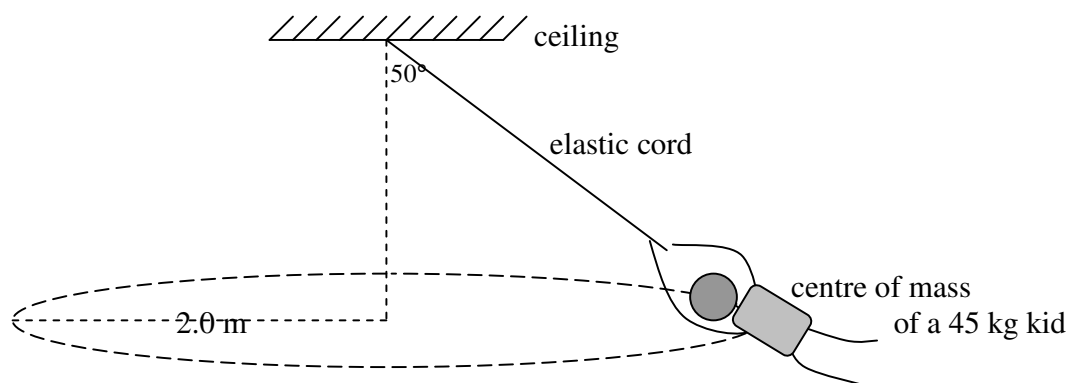
2 marks

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}

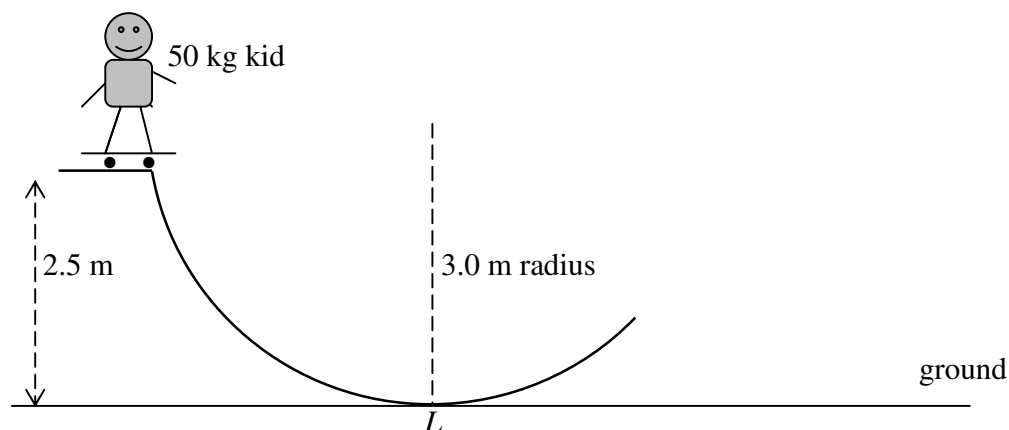
2 marks

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

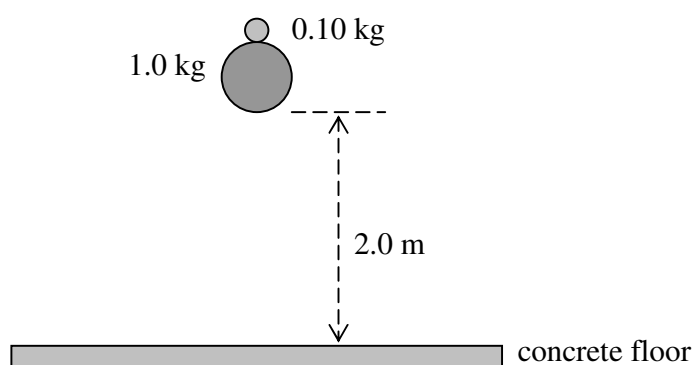
Use the following information to answer Questions 10, 11, 12, 13 and 14

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

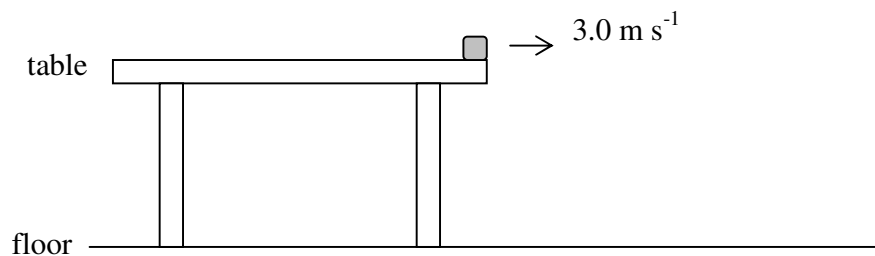
3 marks

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

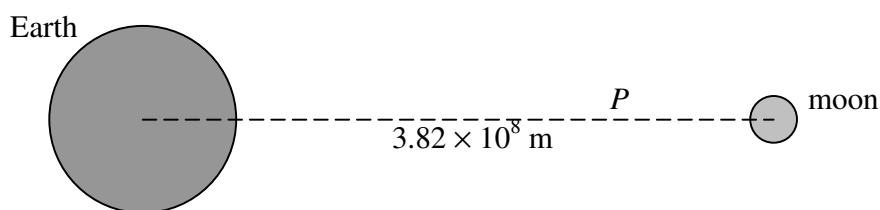
3 marks

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

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 .

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.

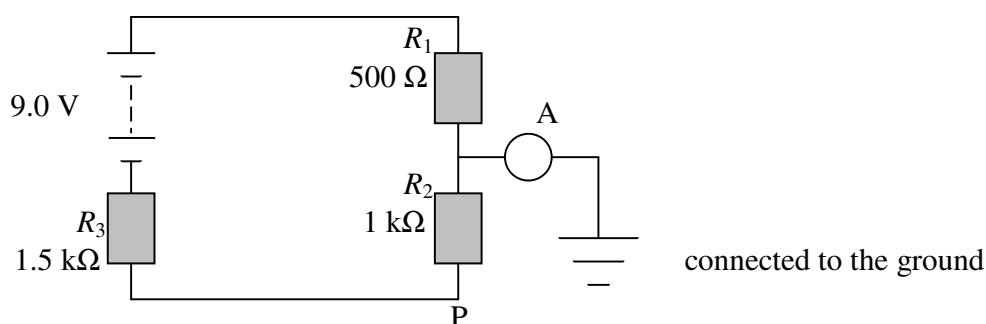
 m

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 .



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

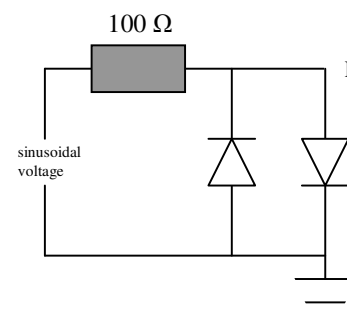
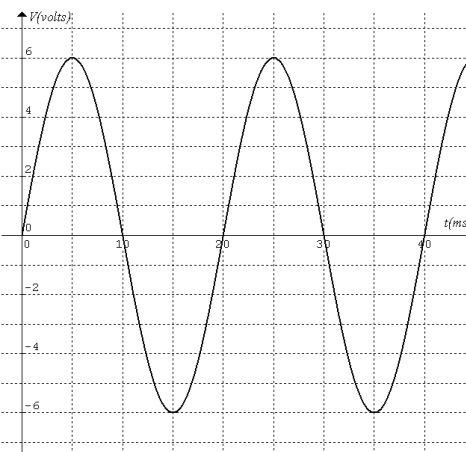
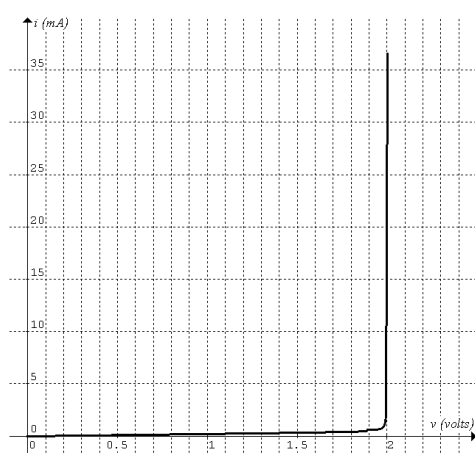
2 marks

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 $100\ \Omega$ resistor to the sinusoidal voltage (6 V amplitude). The circuit is shown below.

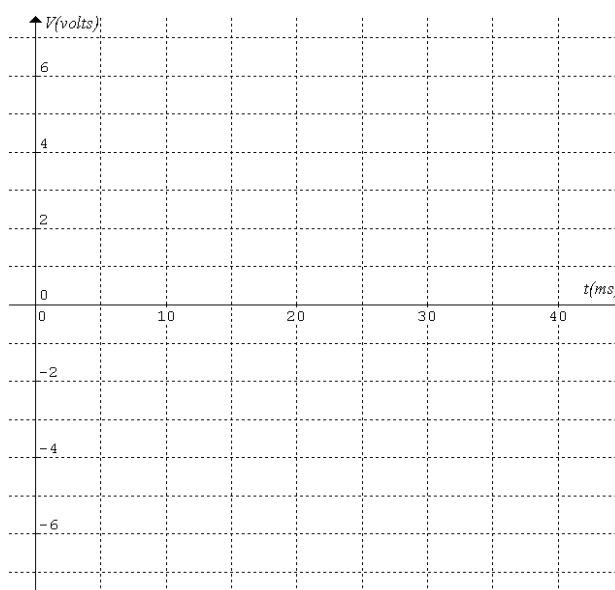


Question 5 Determine the highest current through the $100\ \Omega$ resistor.

mA

2 marks

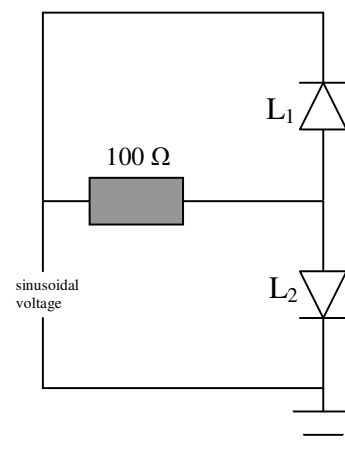
Question 6 Sketch accurately the voltage at point P .



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?

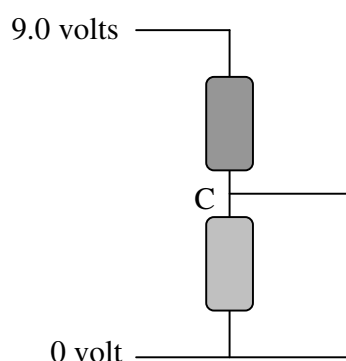
- A. Both L_1 and L_2 go on and off simultaneously.
- B. When L_1 is on, L_2 is off and vice versa.
- C. L_2 goes on and off, whilst L_1 is off.
- D. L_1 goes on and off, whilst L_2 is off.
- E. L_2 goes on and off, whilst L_1 remains on.



2 marks

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

An non-contact switch consists of a LDR and a $5\text{ k}\Omega$ 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.

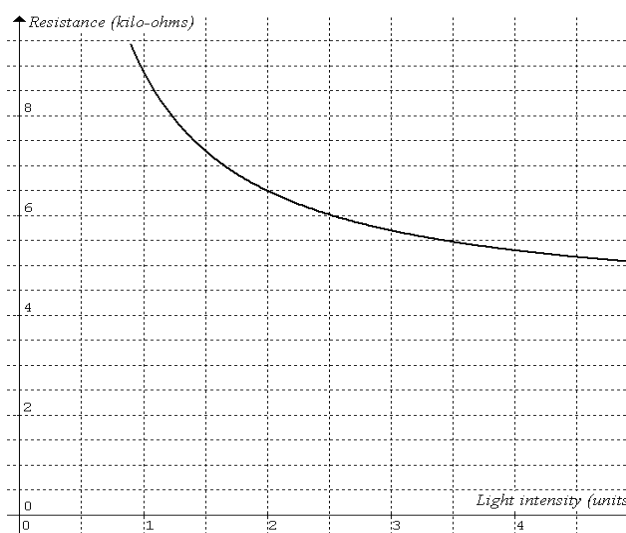
2 marks

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

$\text{k}\Omega$

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 .

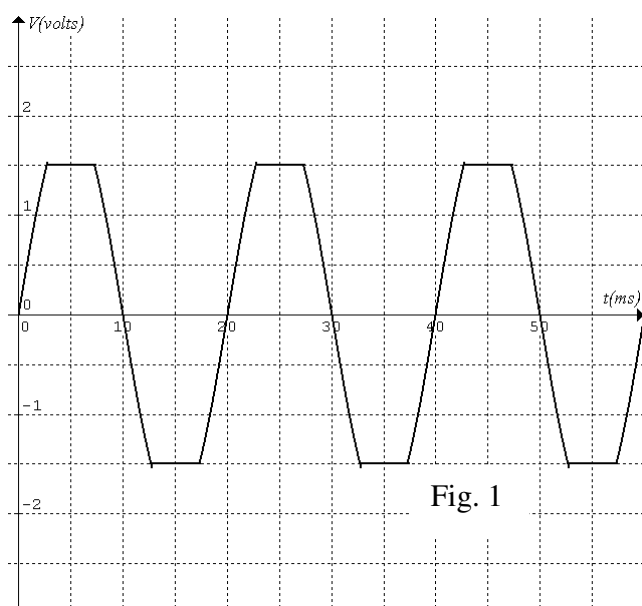


Fig. 1

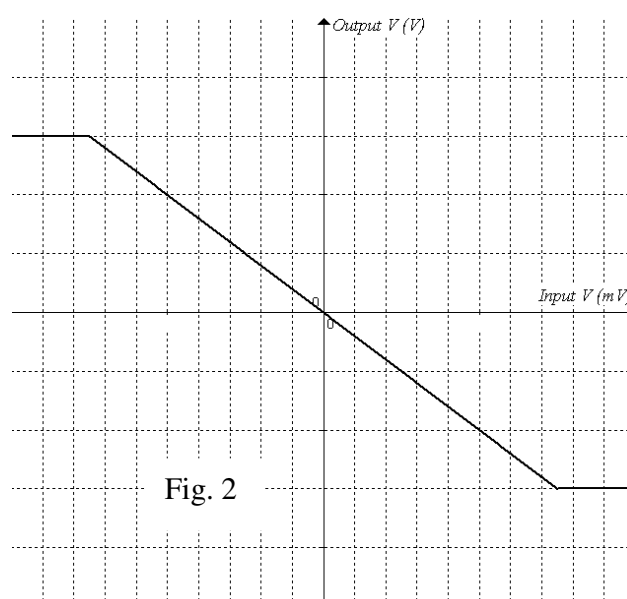


Fig. 2

Question 11 Determine the period of the input signal.

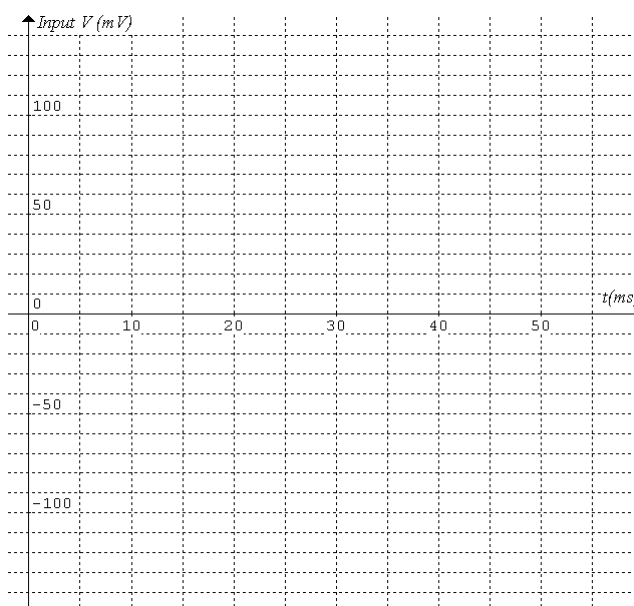
ms

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.



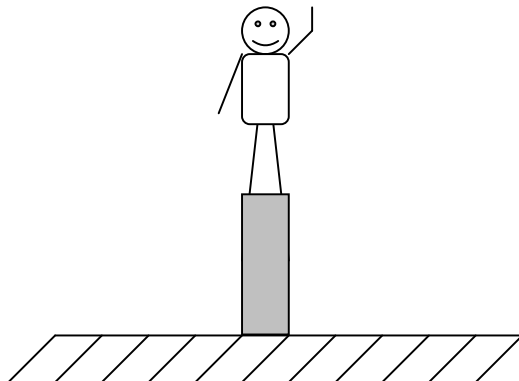
2 marks

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

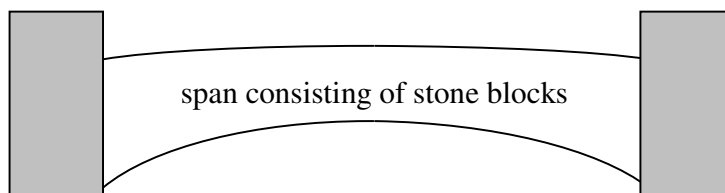
2 marks

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

- A. 4.5 N m^{-2}
- B. $4.5 \times 10^4 \text{ N m}^{-2}$
- C. $5.5 \times 10^4 \text{ N m}^{-2}$
- D. $6.5 \times 10^4 \text{ N m}^{-2}$

2 marks

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



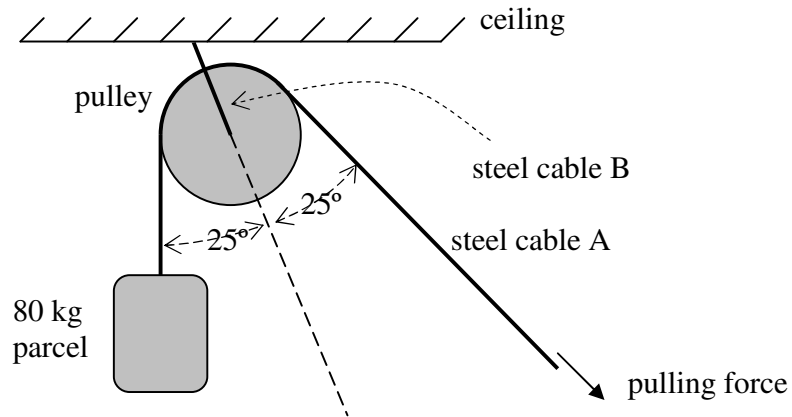
Choose the best description of the span.

- 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

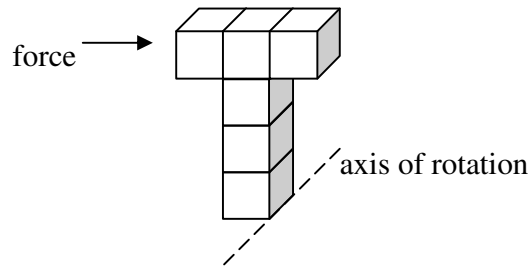
Question 6 The strain in steel cable B is closest to

- 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

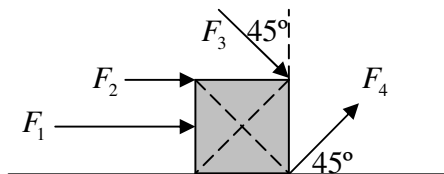
Question 8 The cube on the extreme right exerts a torque on the structure. The magnitude of the torque about the axis of rotation is closest to

- A. $5 \times 10^{-6} \text{ N m}$
- B. $1 \times 10^{-5} \text{ N m}$
- C. $5 \times 10^{-5} \text{ N m}$
- D. $1 \times 10^{-4} \text{ N m}$

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.



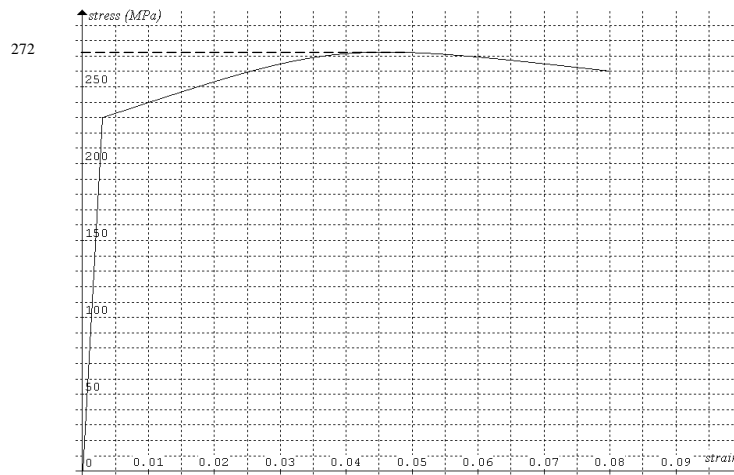
The force that can cause the cube to roll is

- 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