# PHYSICS

2010

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.

Suppose a 120-m diameter ferris wheel rotates once every minute at **uniform** speed in the clockwise direction. Three capsules are marked as *A*, *B* and *C*.
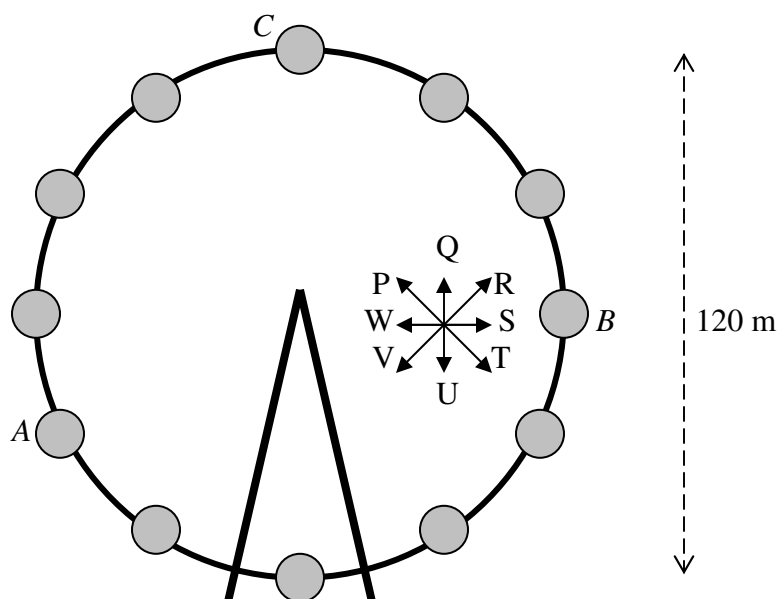
Question 1 Calculate the speed of capsule *C*.

| ms^{-1} | 2 marks |

Question 2 Calculate the net force on a 75-kg passenger inside capsule *A*.
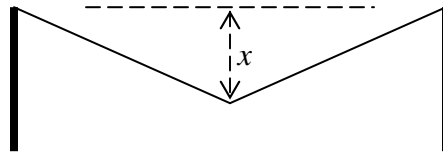
| N | 2 marks |

Question 3 The direction of the net force on capsule *B* is best indicated by arrow (P, Q, R, S, T, U, V or W) shown in the diagram.
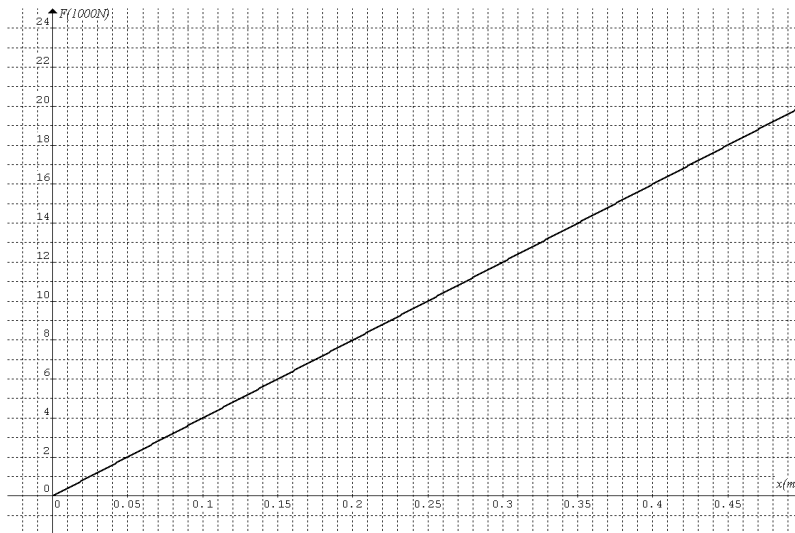
2 marks

Use the following information to answer Questions 4 and 5

The diagram shows the cross-section of a trampoline when it is depressed in the middle by *x* metres.

The force-depression graph of the trampoline is shown below.

Question 4   Determine the force constant (in the vertical direction) of the trampoline. Include unit in your answer.

2 marks

Question 5   A 40-kg child falls from rest 2 metres above the middle of the trampoline. Show that the trampoline is depressed by 21 cm (2 significant figures) when the child reaches the lowest point. Assume that the child is a point mass, and air resistance is negligible.

3 marks

2010 Physics Trial Exam 1   © Copyright 2010 itute.com   3

The profile of a ski slope is shown below. The section QR inside the dotted box is parabolic in shape. The ski slope at point R is at 45° to the horizontal.
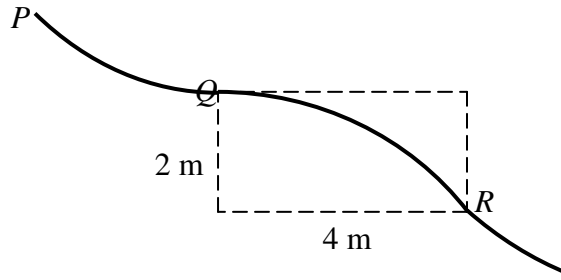
A 75-kg skier moves down the slope from P to Q and continues to R and beyond. Assume that the skier is a point mass, and air resistance and friction are negligible.

Question 6 It is possible for the skier to experience weightlessness while moving **along the entire path** QR. Explain the statement.

2 marks

Question 7 To achieve the situation described in Question 6, the skier must move at certain speed V ms^{-1} at point Q. In terms of V, what is the magnitude of the vertical component of the skier's velocity at point R?

ms^{-1}

2 marks

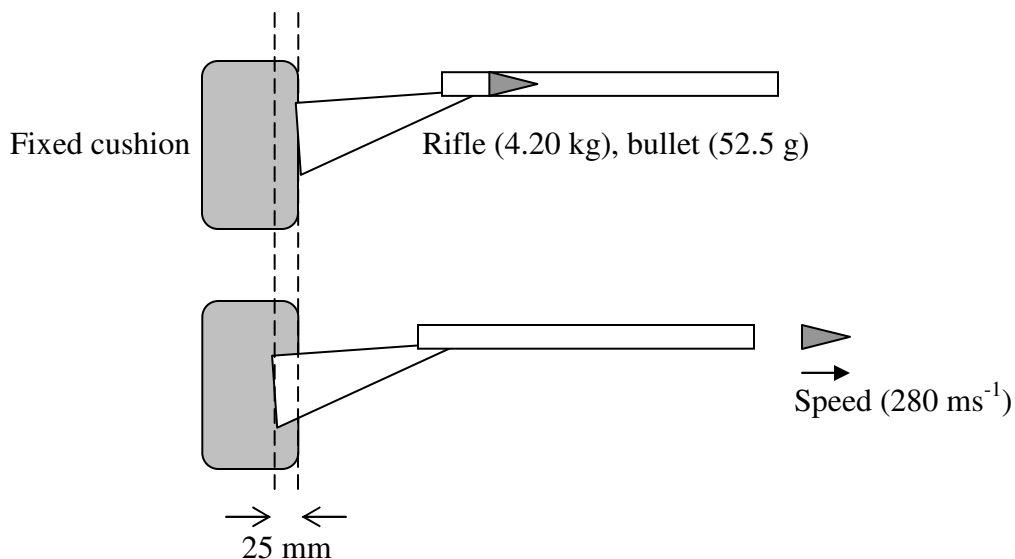**Question 8** Calculate the value of V (2 significant figures).

2 marks

Question 9 Calculate the time taken to move from Q to R in the situation described in Question 6.

s

2 marks

Before firing

Fixed cushion   Rifle (4.20 kg), bullet (52.5 g)

After firing

Speed (280 ms^{-1})

25 mm

Question 10 Calculate the change in momentum of the bullet.

| kg ms^{-1} |

2 marks

Question 11 Calculate the recoil speed of the rifle immediately after firing.

| ms^{-1} |

2 marks

Question 12 Calculate the average force exerted by the cushion in stopping the rifle.
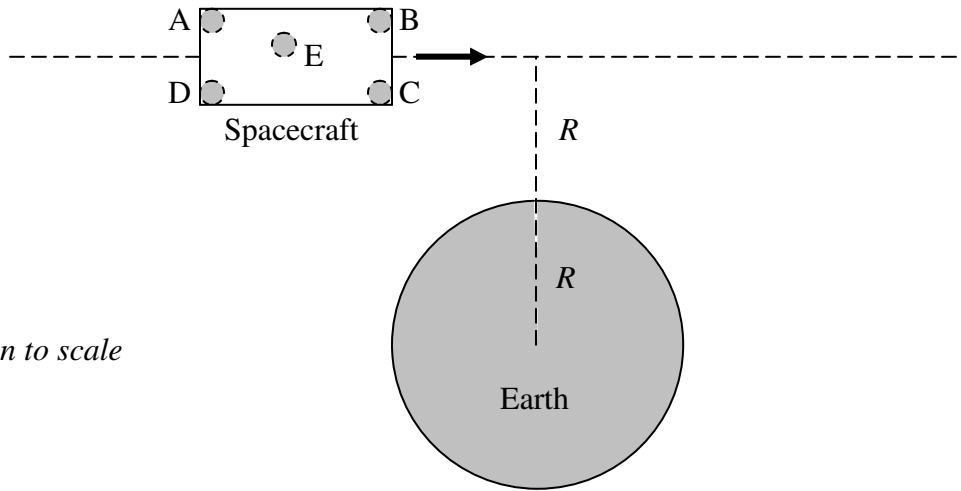
| N |

2 marks

Question 13 There are many forces involved in the situation. Choose a pair of *horizontal* forces to illustrate Newton's third law.

2 marks

A spacecraft travels in a straight line at constant speed near the earth. The closest approach to the earth is R from the surface of the earth, where R is the radius of the earth.

A ☐ ☐ B
E
D ☐ ☐ C
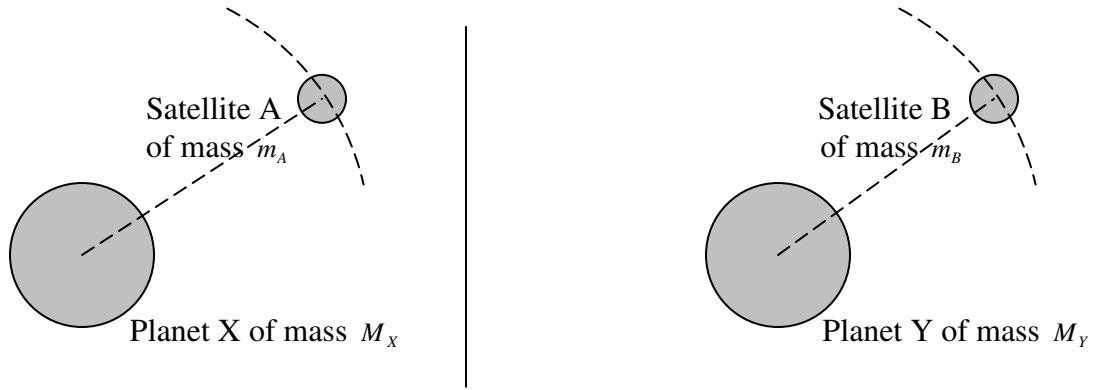Spacecraft

R

R

Earth

NOT drawn to scale

Question 14 Which one of the locations (A, B, C, D or E) inside the spacecraft is the most likely place to find an unrestrained ball?

2 marks

Question 15 The weight of the ball is 9.6 N at the surface of the earth. Calculate the weight of the ball when the spacecraft is closest to the earth.

N   2 marks

Satellite A
of mass m_A

Planet X of mass M_X

Satellite B
of mass m_B

Planet Y of mass M_Y

The mass of planet Y is two times the mass of planet X, i.e. $M_Y = 2 \times M_X$. The mass of satellite B is two times the mass of satellite A, i.e. $m_B = 2 \times m_A$. The two satellites are in circular orbits of the same radius.

Question 16 Calculate the value of the ratio $\dfrac{\text{acceleration of satellite B}}{\text{acceleration of satellite A}}$.

2 marks

Question 17 Calculate the value of the ratio $\dfrac{\text{gravitational force of planet Y on satellite B}}{\text{gravitational force of planet X on satellite A}}$.
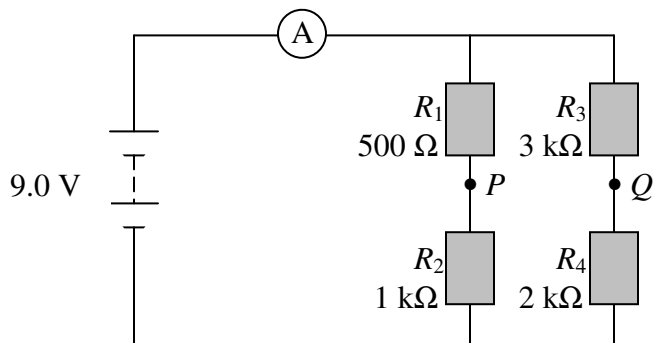
2 marks

Question 18 Calculate the value of the ratio $\dfrac{\text{period of satellite B}}{\text{period of satellite A}}$.

2 marks

Area of study 2 – Electronics and photonics

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

The following circuit consists of a battery supplying a constant voltage of 9.0 V, an ammeter A, and four ohmic resistors R_1, R_2, R_3 and R_4.

Question 1 What is the potential difference between point P and point Q?

	V

3 marks

Question 2 Calculate the current through the ammeter.

	mA

3 marks

Question 3 Calculate the **total** power dissipated in the four resistors R_1, R_2, R_3 and R_4.

	W

2 marks

The following graphs show the *i-v* characteristics of a silicon diode and an ohmic resistor. The diode is connected in series to the resistor, and the circuit is powered by a battery providing a constant voltage of 1.5 V. The circuit is shown below.
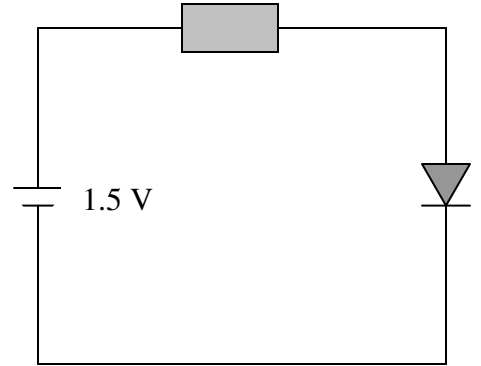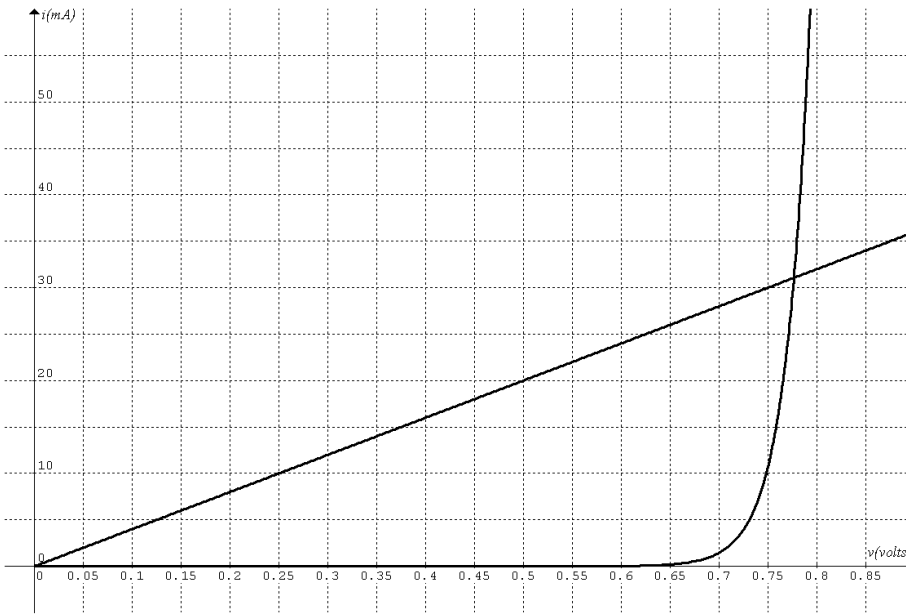
Question 4 Determine the resistance of the ohmic resistor.

Ω

2 marks

Question 5 Determine the current (2 significant figures) through the diode.

mA

3 marks

Fig. 1 shows the voltage-transfer curve of a voltage amplifier. Fig. 2 shows an input signal to the amplifier.
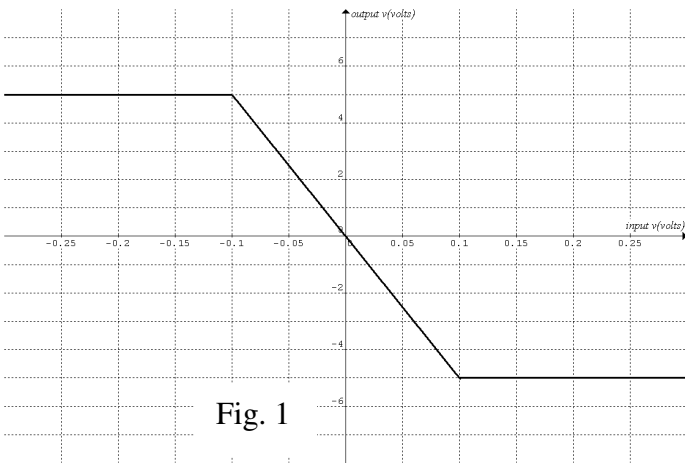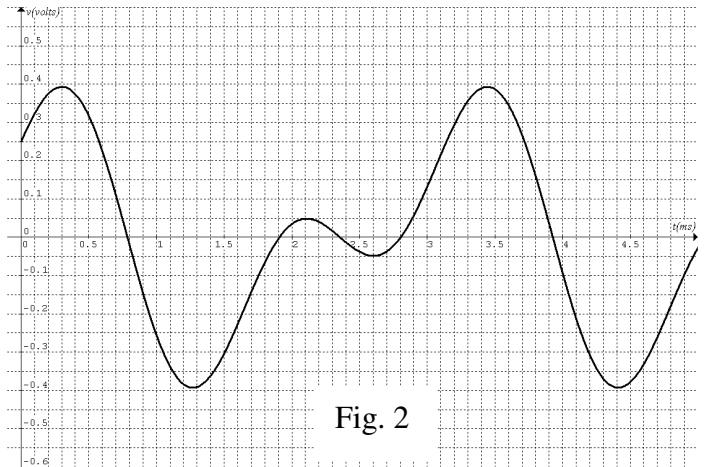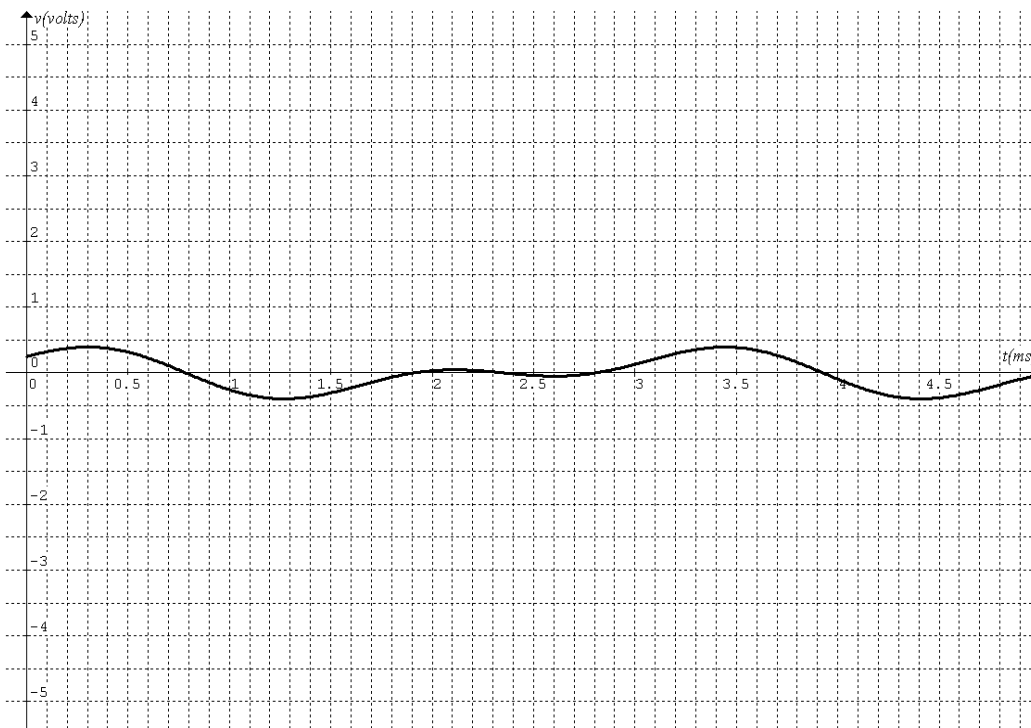

Fig. 1

Fig. 2

Question 6   Determine the voltage gain of the amplifier.
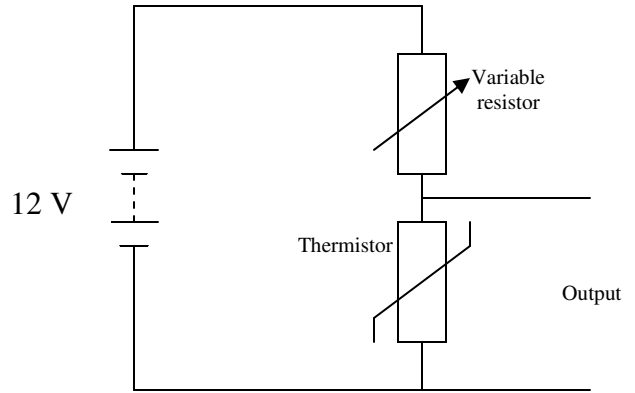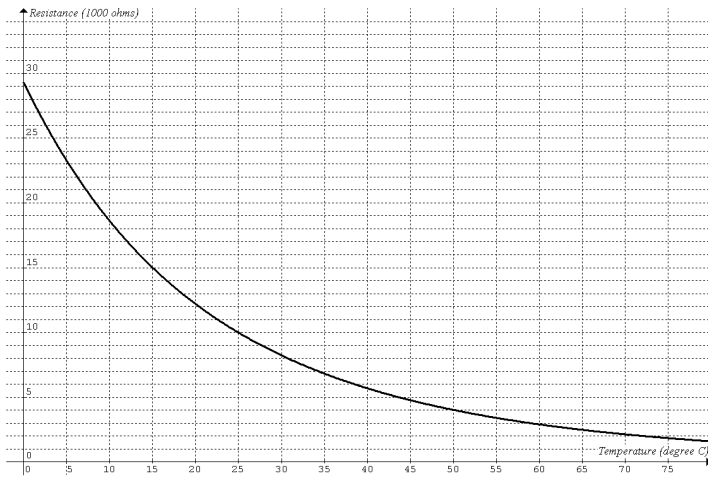
2 marks

Question 7   The input signal to the amplifier is shown again in the following enlarged grid with a different vertical scale. On the same grid sketch the corresponding output signal of the amplifier.

3 marks

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

The resistance of a thermistor as a function of temperature is shown below. It is connected in series with a variable resistor, and the circuit is powered by a constant 12-V dc source. The output turns on an alarm when the voltage across it is at or above 4.0 volts.

Question 8   What is the ambient temperature when the resistance of the thermistor is 10 kΩ?

°C	

1 mark

Question 9   Determine the preset resistance of the variable resistor in order to turn on the alarm at 15°C.
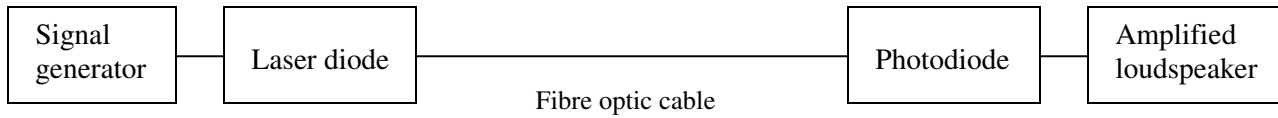
2 marks

Question 10   *Explain* whether the alarm will remain on when the ambient temperature is below 15°C.
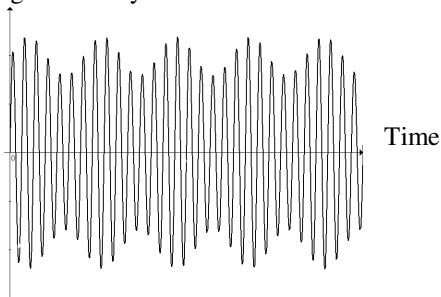
3 marks

Use the following information to answer Questions 11 and 12

The following schematic diagram shows an analog communication system using light intensity modulation and demodulation.
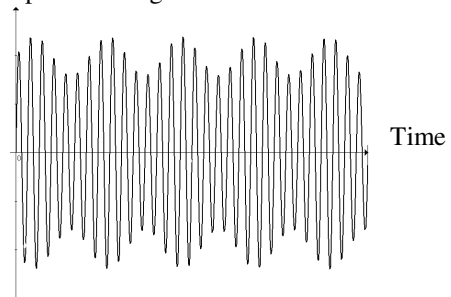
| Signal generator | Laser diode | | Photodiode | Amplified loudspeaker |

Fibre optic cable

Question 11 Which one of the following graphs best represents the signal in the fibre optic cable when the signal generator is turned *off*?
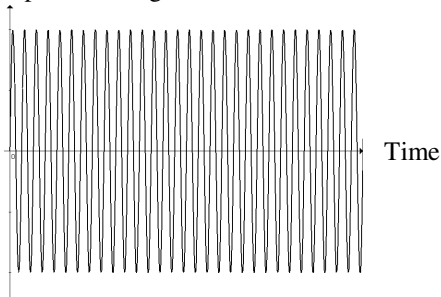
A. Light intensity

Time

B. Amplitude of light wave
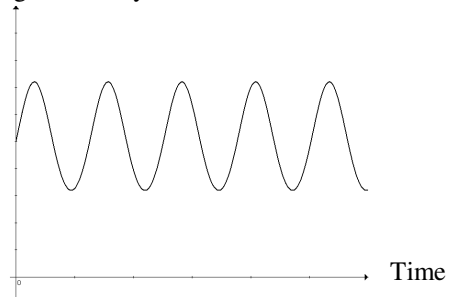
Time

C. Amplitude of light wave

Time

D. Light intensity

Time

1 mark

Question 12 Which one or more of the above graphs best represent the signal in the fibre optic cable when the signal generator is turned *on*?
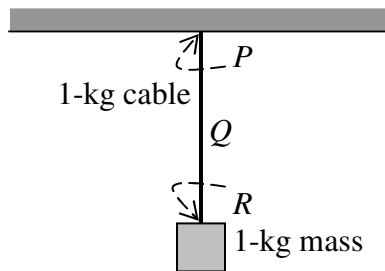
2 marks

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 1-kg mass is suspended by a 1-kg cable of uniform cross-section.

Question 1 The tension in the cable is

A.   the greatest at point *P*
B.   the greatest at point *Q*
C.   the greatest at point *R*
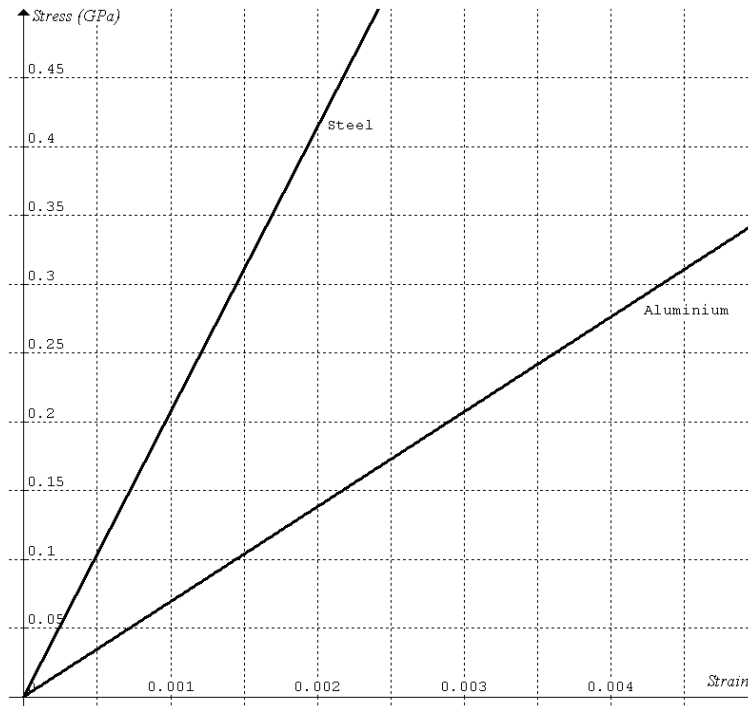D.   the same along its entire length

2 marks

Question 2 The stress in the cable is

A.   the greatest at point *P*
B.   the greatest at point *Q*
C.   the greatest at point *R*
D.   the same along its entire length

2 marks

The graph below shows the elastic behaviour of steel and aluminium.

Question 3   The modulus of elasticity E (Young's modulus) of aluminium is

A.   70 kPa m^{-1}
B.   69 GPa
C.   210 GPa m^{-2}
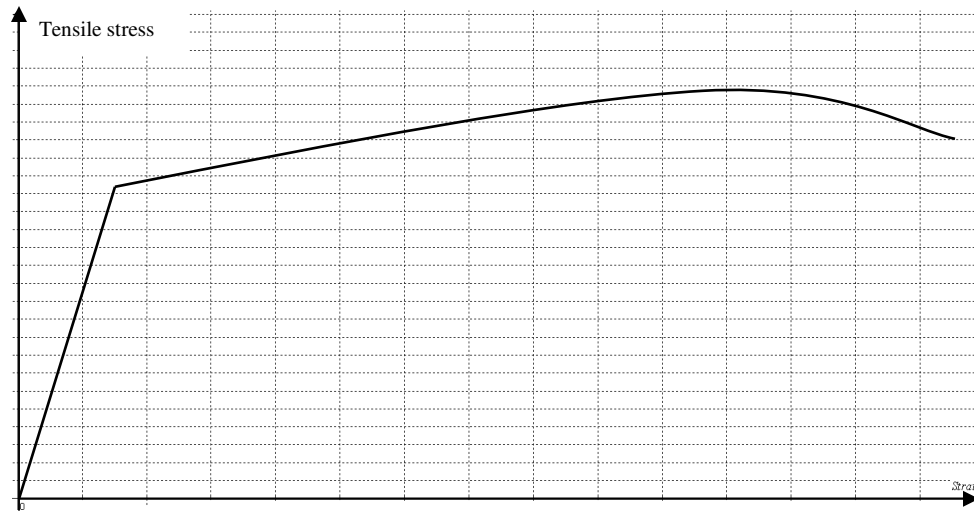D.   207 kPa

2 marks

Question 4   For the same stress, the ratio $\dfrac{\varepsilon_{alu\,min\,ium}}{\varepsilon_{steel}} =$

A.   2.2
B.   0.33
C. $\dfrac{E_{alu\,min\,ium}}{E_{steel}}$
D. $\dfrac{E_{steel}}{E_{alu\,min\,ium}}$

2 marks

The stress-strain curve of a material is shown up to the fracture point.

Question 5   For the material which of the following alternatives is correct?

A.   Yield strength > breaking strength > tensile strength
B.   Breaking strength > yield strength > tensile strength
C.   Tensile strength > breaking strength > yield strength
D.   Breaking strength > tensile strength > yield strength

2 marks

Question 6   For the material which of the following alternatives is correct?

A.   The stress at which the material changes from elastic to plastic behaviour is easily detected.
B.   The material is elastic because it absorbs a large amount of energy before it breaks.
C.   The material is tough because it has a high fracture stress.
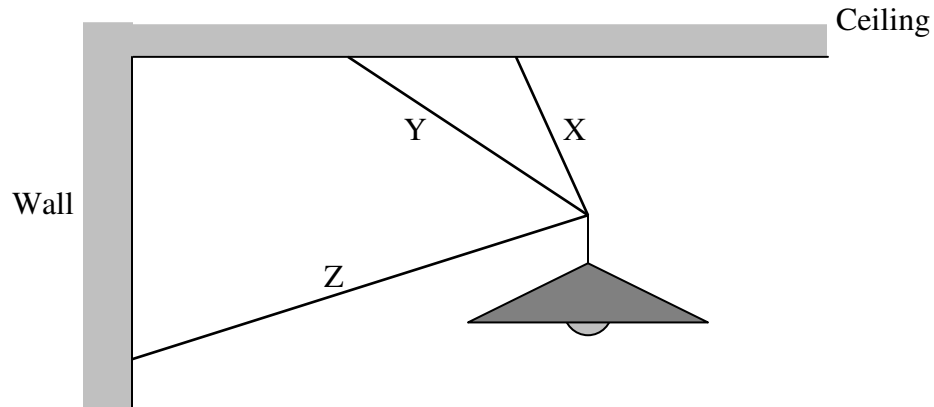D.   The material is ductile because its stress-strain curve is not linear.

2 marks

Question 7   A likely material with a similar stress-strain curve is

A.   glass
B.   concrete
C.   aluminium
D.   cast iron

2 marks

Use the following information to answer Questions 8 and 9

A lamp is held in position by three cables/rods X, Y and Z.

Question 8   Which one of the following statements ***cannot*** be true?

A.   X is a cable, Y is a rod and Z is a cable.
B.   X is a rod, Y is a cable and Z is a rod.
C.   X is a cable, Y is a cable and Z is a rod.
D.   X is a cable, Y is a cable and Z is a cable.

2 marks

Question 9   Which one of the following situations is ***impossible***?

A.   X is in compression, Y is in tension and Z is in compression.
B.   X is in tension, Y is in compression and Z is in compression.
C.   X is in tension, Y is in tension and Z is in compression.
D.   X is in tension, Y is in compression and Z is in tension.

2 marks

Question 10   A cylindrical tree stump of diameter 0.80 m is pulled with a cable around it near the ground. The tension in the cable is 8900 N.


The shear stress on the stump near the ground is closest to

A.   0.5 kPa
B.   2 kPa
C.   4 kPa
D.   20 kPa

2 marks

The following diagram shows the aerial view of a door with a spring-closer, which closes the door automatically. The door is kept open by a hand pulling the door knob with a 3-newton horizontal force. The horizontal distance from the door knob to the hinges is 75 cm

Hinges

Spring closer

120°

3 N

Aerial view
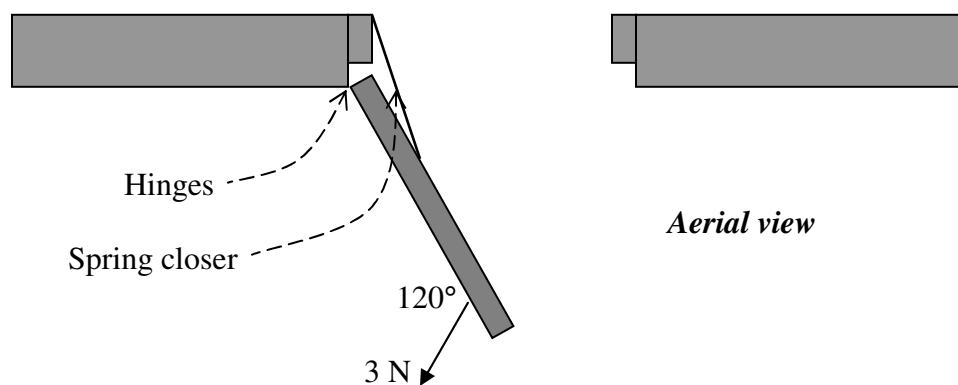
Question 11   The net torque on the door is

A.   in the clockwise direction.
B.   in the anticlockwise direction.
C.   zero.
D.   indeterminable.

2 marks

Question 12   The torque of the pulling force is

A.   1.95 Nm clockwise.
B.   195 Nm anticlockwise.
C.   2.25 Nm anticlockwise.
D.   2.25 Nm clockwise.

2 marks

Question 13   The torque of the spring-closer is

A.   1.95 Nm anticlockwise.
B.   195 Nm clockwise.
C.   2.25 Nm anticlockwise.
D.   indeterminable.

2 marks

End of Trial Exam 1