Neap:

Trial Examination 2014

VCE Physics Unit 3

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Number of marks
A Core – Areas of study	12	12	68
B Detailed studies	11	11	22
			Total 90

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, one folded A3 sheet or two A4 sheets of notes and one scientific calculator.

Students are NOT permitted to bring into the examination room: blank pieces of paper and/or white out liquid/tape.

Materials supplied

Question and answer booklet of 29 pages with a detachable data sheet in the centrefold.

Answer sheet for multiple-choice questions.

Instructions

Detach the data sheet from the centre of this booklet during reading time.

Please ensure that you write your **name** and your **teacher's name** in the space provided on this booklet and on the answer sheet for multiple-choice questions.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2014 VCE Physics Units 3&4 Written Examination.

SECTION A – CORE

Instructions for Section A

Answer **all** questions in this section in the spaces provided. Write using black or blue pen.
Where an answer box has a unit printed in it, give your answer in that unit.
Where answer boxes are provided write your final answer in the box.
In questions worth more than one mark appropriate working should be shown.
You should take the value of g to be 10 m s^{-2}.

Areas of study Page

Motion in one and two dimensions 3

Electronics and photonics 12

Area of study 1 – Motion in one and two dimensions

Question 1 (8 marks)

To assist him in understanding the physics of motion of objects under the influence of gravity, Galileo Galilei used small metal balls running down grooved inclined planes to 'slow the effect of gravity down'. One such inclined plane of length 2.0 m is shown in Figure 1. Assume resistance effects are negligible and that the metal ball is released from rest.

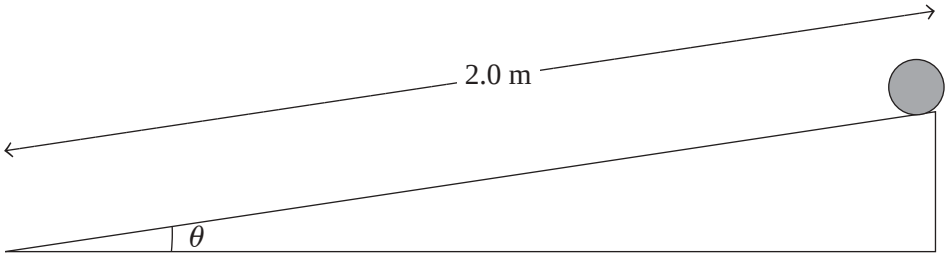


Figure 1

a. Calculate the angle θ (in degrees) required to make the acceleration down the grooved inclined plane exactly 1.0 m s^{-2}. 2 marks

°

b. Calculate how long it takes the metal ball to roll down the 2.0 m inclined plane. 2 marks

s

c. Galileo Galilei replaced his metal ball of mass M with one of mass $2M$ but kept all the other parameters in his experiment the same.

The ratio of the time taken for the ball of mass $2M$ to roll down the inclined plane compared to the time taken for the ball of mass M to roll down the plane is 2 marks

A. 2 : 1

B. $\sqrt{2}$: 1

C. 1 : 1

D. 1 : 2

d. Galileo Galilei then used his original metal ball of mass M but changed the length of his inclined plane to 4.0 m, while keeping the other parameters in his experiment the same.

The ratio of the time taken for the ball of mass M to roll down the inclined plane of 4.0 m compared to the time taken for the ball of mass M to roll down the inclined plane of 2.0 m is 2 marks

A. 4 : 1

B. 2 : 1

C. $\sqrt{2}$: 1

D. 1 : 1

Question 2 (6 marks)

A car of mass 1500 kg is pulling a trailer of mass 500 kg to the right as shown in Figure 2. The frictional force acting on both the car and the trailer is 1.0 N per kg.

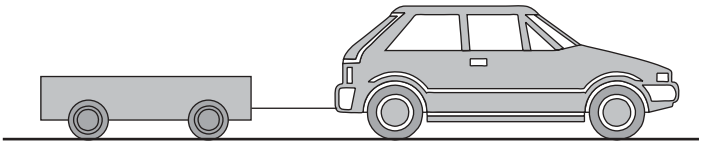


Figure 2

a. Calculate the magnitude of the engine force required to move the car and the trailer at a constant velocity. 2 marks

N

b. Calculate the tension in the tow bar between the car and the trailer. 2 marks

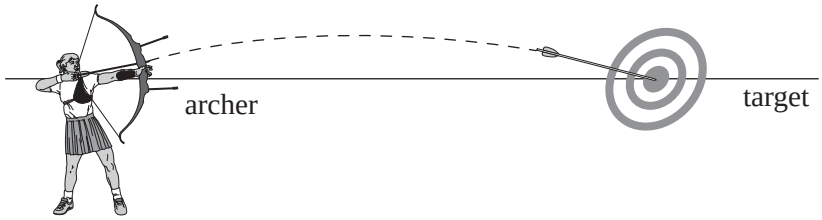
N

c. The car now accelerates with an acceleration of 3.0 m s^{-2}.
Calculate the tension in the tow bar between the car and the trailer for this situation. 2 marks

N

Question 3 (7 marks)

In archery the target is a distance of 90 m from the archer (Figure 3). The speed of the arrow at the highest point is 45 m s^{-1}. The arrow is launched at an angle θ from the horizontal. Assume the arrow hits the bull's eye which is at the same level as the shot arrow.



(not to scale)

Figure 3

a. How long is the arrow in the air? 1 mark

s

b. Calculate the angle θ from the horizontal at which the arrow leaves the bow. 3 marks

°

c. The arrow leaves the bow at a height of 1.8 m above the ground.

Calculate the maximum height that the arrow is above the ground on its journey from the bow to the target. 3 marks

m

Question 4 (5 marks)

A conical pendulum is set spinning as shown in Figure 4. The radius, *r*, is 0.5 m, the mass, *m*, is 2.0 kg and the speed of the mass is 4 m s^{-1}.

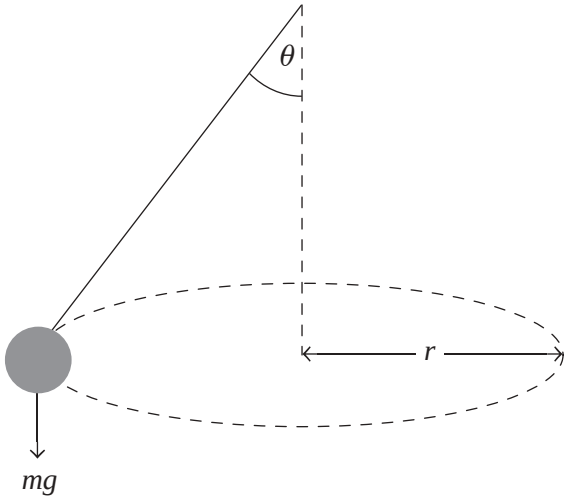


Figure 4

a. Calculate the angle θ (in degrees). 3 marks

°

b. Calculate the tension in the string. 2 marks

N

Question 5 (4 marks)

A roller coaster of total mass (with passengers) 500 kg is going at a speed of 18 km h^{-1} at the top of the ride, as shown in Figure 5. Assume frictional forces are negligible and that the bottom represents ground level.

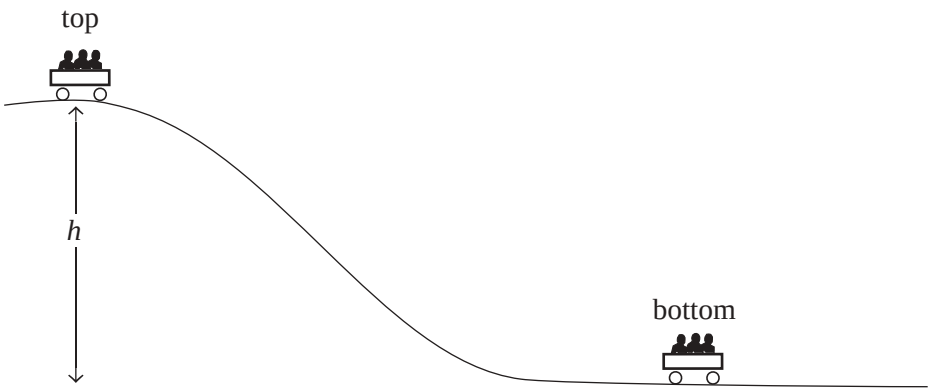


Figure 5

a. Which of the following statements is true concerning the potential energy (PE) and the kinetic energy (KE) at the top and the bottom of the roller coaster ride? 1 mark

A. $PE_{TOP} = KE_{BOTTOM}$

B. $KE_{TOP} + PE_{TOP} = KE_{BOTTOM}$

C. $KE_{TOP} + PE_{TOP} = KE_{BOTTOM} + PE_{BOTTOM}$

D. none of the above

b. If the speed at the bottom of the ride is 180 km h^{-1}, calculate the height, *h*, (in metres). 3 marks

m

Question 6 (5 marks)

Figure 6 shows the force versus compression graph of two different types of springs used in mattresses (spring *P* and spring *Q*). Each mattress has 20 springs.

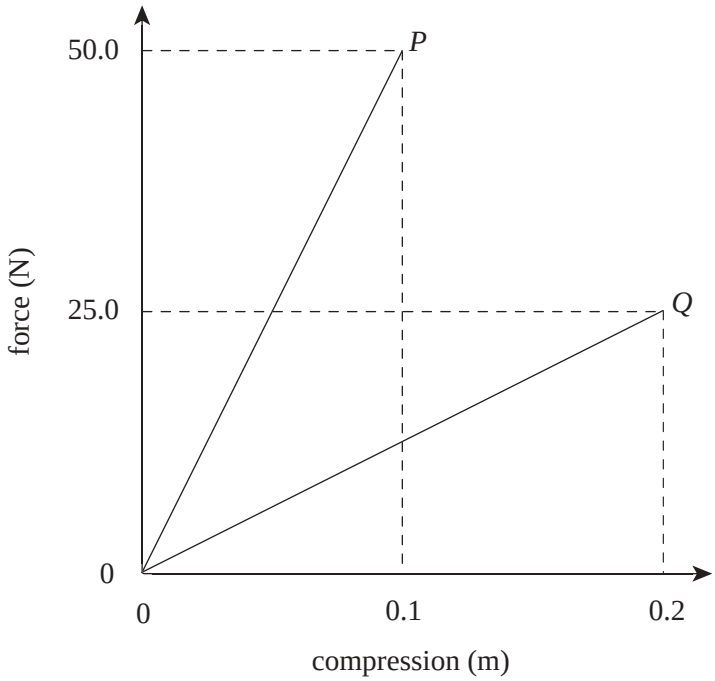


Figure 6

a. Circle which mattress is firmer: that using

spring *P* or spring *Q*

Explain your reason for selecting this spring. 2 marks

_____

_____

_____

_____

b. An 80 kg person sleeps on a bed made with 20 type *P* springs.

Calculate the total energy stored in the mattress springs. Assume that the weight is spread evenly over the 20 springs. 3 marks

J

Question 7 (5 marks)

The Hubble Space Telescope of mass 11 tonnes is orbiting the Earth at a radius of 6970 km, as shown in Figure 7.

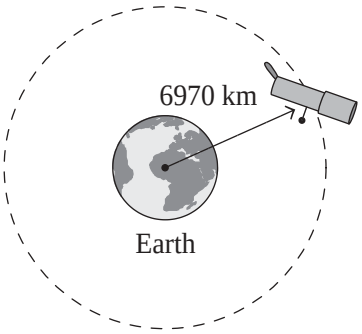


Figure 7

a. Calculate the period of orbit (in hours) of the Hubble Space Telescope. 3 marks

hr

b. Calculate the force acting on the Hubble Space Telescope due to the Earth's gravity. 2 marks

N

END OF AREA OF STUDY 1

Area of Study 2 – Electronics and photonics

Question 1 (6 marks)

Figure 1 shows a compound electrical circuit made up of a series and parallel combination of resistors. There is potential difference between points *A* and *B*.

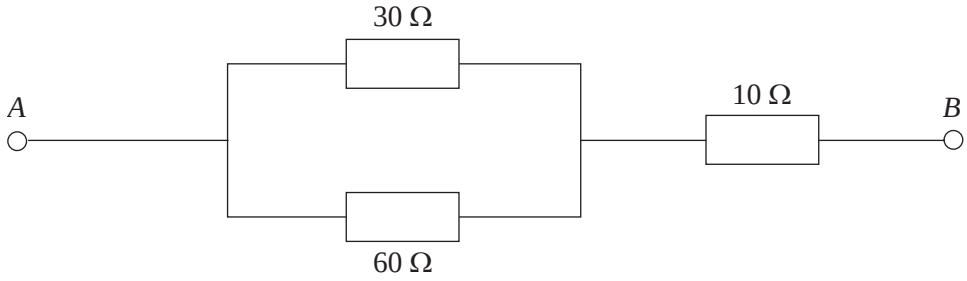


Figure 1

a. Calculate the total equivalent resistance of the series and parallel combination of resistors. Show your working. 2 marks

Ω

b. Calculate the voltage drop across the 60 Ω resistor if the voltage drop across the 10 Ω resistor is 6.0 V. 2 marks

V

c. If the current in the 60 Ω resistor is *I*, determine the current in the 30 Ω resistor and the 10 Ω resistor as some fraction or multiple of *I*.

30 Ω resistor: 1 mark

10 Ω resistor: 1 mark

Question 2 (5 marks)

Figure 2 shows the resistance versus temperature graph for a thermistor used as a temperature control device.

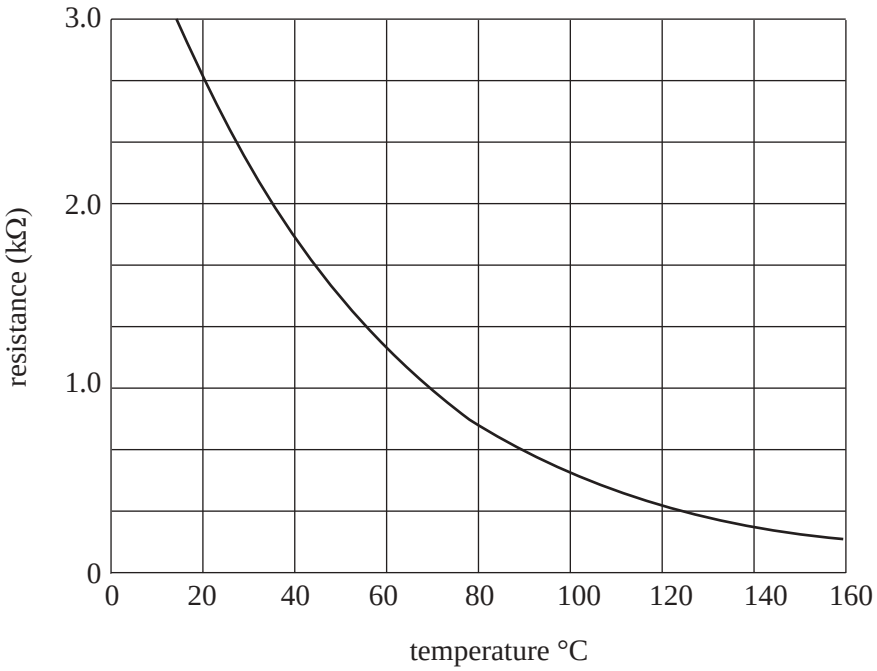


Figure 2

a. Is the thermistor a linear or non-linear device? Explain your answer. 2 marks

_____

_____

_____

_____

_____

_____

_____

b. From the graph determine the temperature when the resistance is 1000 Ω. 1 mark

°C

The thermistor is placed in a circuit with a variable resistor as shown in Figure 3. If the voltage drop across $YZ \geq 6.0$ V, a buzzer sounds. The voltage drop across $XZ = 9.0$ V.

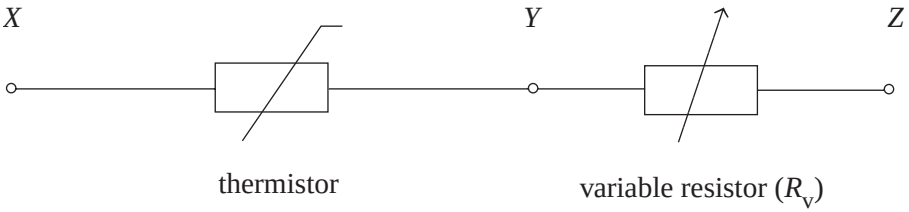


Figure 3

c. Calculate the minimum value that the variable resistor is required to be set at so that the buzzer sounds when the thermistor is at a temperature of 20°C.
You must show your working. 2 marks

Ω

Question 3 (6 marks)

Figure 4 shows an oscilloscope trace of the output from a voltage amplifier. Each vertical grid line shows a voltage of 10 V. The input to the voltage amplifier is an AC signal generator with peak-to-peak voltage of 500 mV.

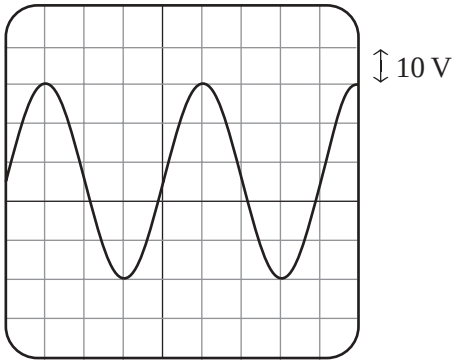


Figure 4

a. Determine the RMS output voltage of the voltage amplifier. You must show your working. 2 marks

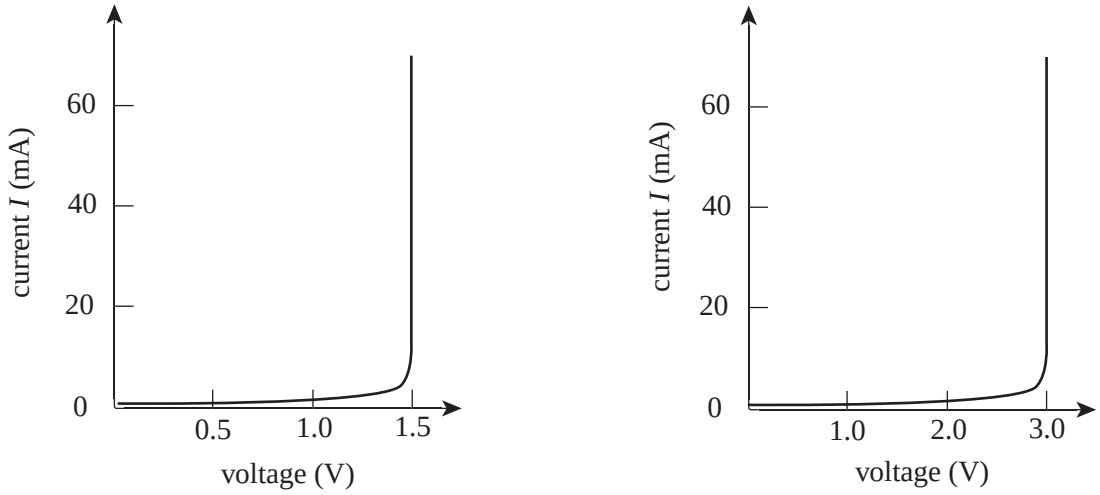
V

b. Calculate the gain of the voltage amplifier. 2 marks

c. Explain the concept of clipping as it applies to amplifiers. 2 marks

Question 4 (6 marks)

Some students are using two different LEDs in an Electronics and Photonics Physics practical.
The two different diodes D_1 and D_2 have the characteristic graphs as shown in Figure 5 below.



Characteristics of LED D_1 **Characteristics of LED D_2**

Figure 5

Using the LED D_2, the students set up the following circuit shown in Figure 6. The value of R_D is 2 kΩ.

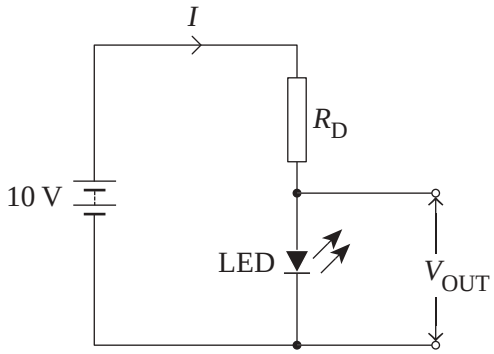


Figure 6

a. Calculate the value of the current in the resistor R_D. Show your working. 2 marks

mA

b. The students now place both LEDs in series with the resistor R_D.

In the space below, draw the new circuit arrangement. 2 marks

c. Calculate the value of the current in the resistor R_D when both LEDs are in series with the resistor R_D. Show your working. 2 marks

mA

Question 5 (5 marks)

Figure 7 shows the illuminance (lux) versus resistance (kΩ) graph for an LDR that is placed in series with a 10 kΩ resistor in a circuit as shown in Figure 8. V_P = 12.0 V and V_R = 0 V. The LDR is used in a circuit that automatically turns the lights on when the external lighting is too dim.

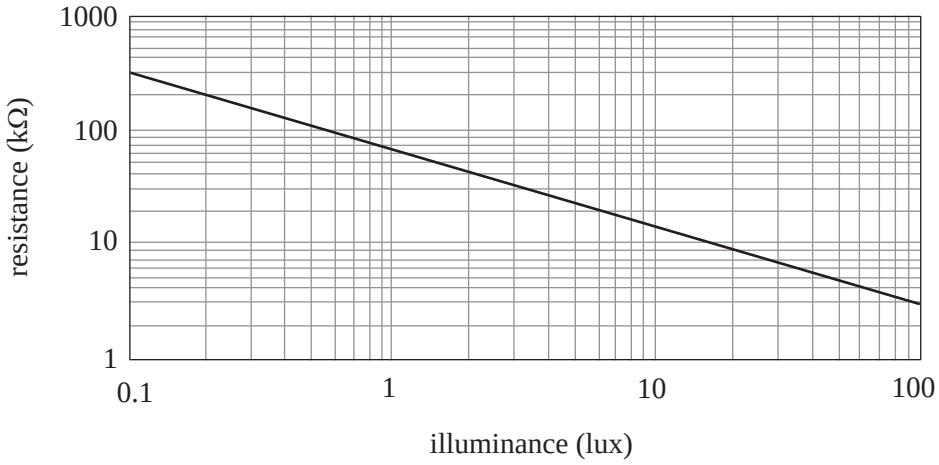


Figure 7

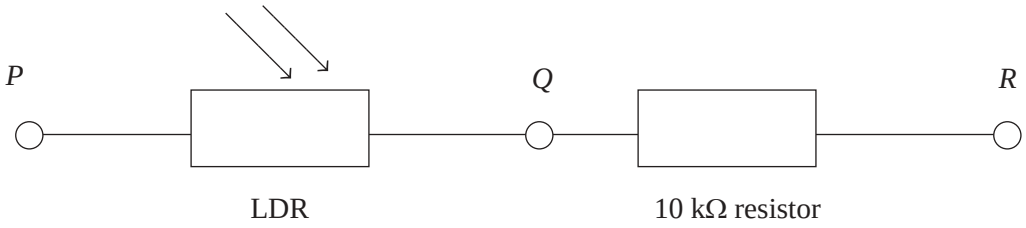


Figure 8

a. Explain what the acronym LDR means. 1 mark

_____

_____

b. Calculate V_{PQ} when the illuminance is 6 lux. 2 marks

V

c. The illuminance in the room goes down to 0.2 lux. For the lights to come on, $V_{PQ} \geq 10.5$ V.

Determine whether the lights will come on when the illuminance in the room is 0.2 lux.
Show calculations to support your answer. 2 marks

END OF AREA OF STUDY 2

SECTION B – DETAILED STUDIES

Instructions for Section B

Select **one** of the following **Detailed studies** and answer **all** questions within that Detailed study in pencil on the answer sheet provided for multiple-choice questions.

Show the Detailed study you are answering by ticking the matching box on your multiple-choice answer sheet.

Choose the response that is **correct** for the question.

A correct answer scores 2, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

You should take the value of g to be 10 m s^{-2}.

Detailed study **Page**

Detailed study 2: Materials and their use in structures 21

Detailed study 6: Sound 26

Detailed Study 2 – Materials and their use in structures

Use the following information to answer Questions 1–3.

The stress–strain relationships for three different materials under tension, *X*, *Y* and *Z*, are as shown in the stress versus strain graph in Figure 1.

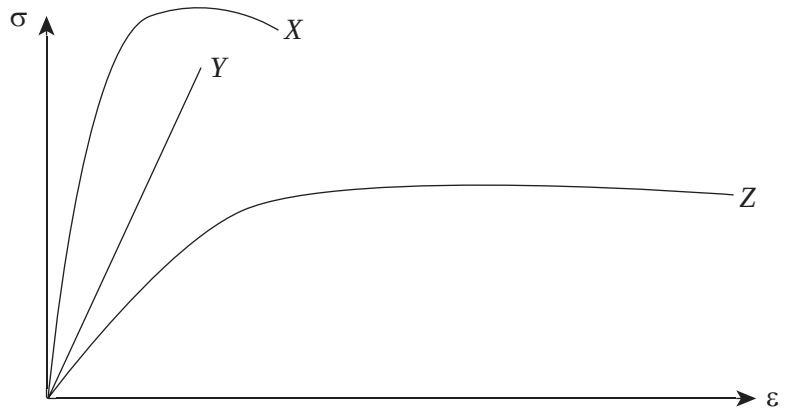


Figure 1

Question 1

Which of the following statements best describes the ultimate tensile strength properties of materials *X* and *Z*?

A. *X* has about half the ultimate tensile strength of *Z*.

B. *X* has the same ultimate tensile strength as *Z*.

C. *X* has about twice the ultimate tensile strength of *Z*.

D. cannot be determined from the information in the graph

Question 2

Which one of the three different materials under tension, *X*, *Y* or *Z*, is most likely to be brittle?

A. *X*

B. *Y*

C. *Z*

D. cannot be determined from the information in the graph

Question 3

Which of the following best describes the relative toughness of the three different materials *X*, *Y* and *Z* from toughest to least tough?

A. $X > Y > Z$

B. $Z > X > Y$

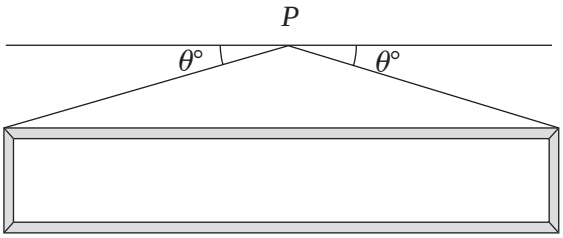
C. $X > Z > Y$

D. $Y > Z > X$

Use the following information to answer Questions 4 and 5.

A painting of mass 20 kg is hung from a point *P* by a wire of cross-sectional area 5 mm^2.

The wire makes an angle of $\theta°$ with the horizontal as shown in Figure 2. The tension in the wire is 174 N.



not to scale

Figure 2

Question 4

The angle $\theta°$ is closest to

A. 35°

B. 45°

C. 50°

D. 55°

Question 5

The tensile stress σ in the wire is closest to

A. 35 Pa

B. 870 Pa

C. 35 kPa

D. 35 MPa

Use the following information to answer Questions 6–8.

The table below details Young's modulus, the ultimate compressive strength and ultimate tensile strength of a concrete known as formulation C7.

Young's modulus for concrete (Y)	Ultimate compressive strength of concrete (σ_c)	Ultimate tensile strength of concrete (σ_t)
25 GPa	25 MPa	6 MPa

The concrete is made into a square column of cross-sectional area 0.20 m^2 (A) and length 3.0 m (L) as shown in Figure 3. The concrete column supports a load of 10.0 tonne.

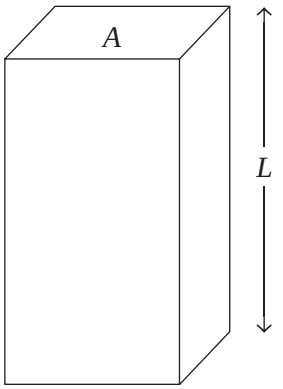


Figure 3

Question 6

The compressive stress in the column when it supports a load of 10.0 tonne is closest to

A. 50 Pa
B. 50 kPa
C. 500 kPa
D. 50 MPa

Question 7

A sample cylinder of 0.5 m^3 is used in testing the C7 formulation to destruction under tension. The stress versus strain graph for concrete under tension is a straight line to the failure point.

The amount of energy (J) required to make the C7 sample cylinder fail under tension is given by

A. $\frac{0.5(\sigma_t)^2}{Y}$

B. $\frac{0.25(\sigma_t)^2}{Y}$

C. $(0.5(\sigma_t)^2)Y$

D. $(0.25(\sigma_t)^2)Y$

Question 8

The engineers who designed the building are concerned about horizontal shear loads causing the concrete to crack.

The best solution for this would be to

A. put horizontal steel reinforcing mesh near the top of the square column.

B. put vertical steel reinforcing meshes near the vertical edges of the square column.

C. put horizontal steel reinforcing mesh near the bottom of the square column.

D. all of the above

Question 9

Figure 4 shows a stone bridge made in the shape of an arch.

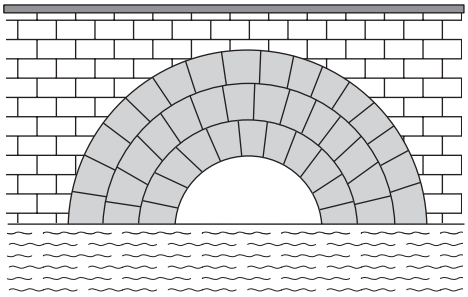


Figure 4

Stone is used to make such a bridge because arches require a material that is strong under

A. tensile stress.

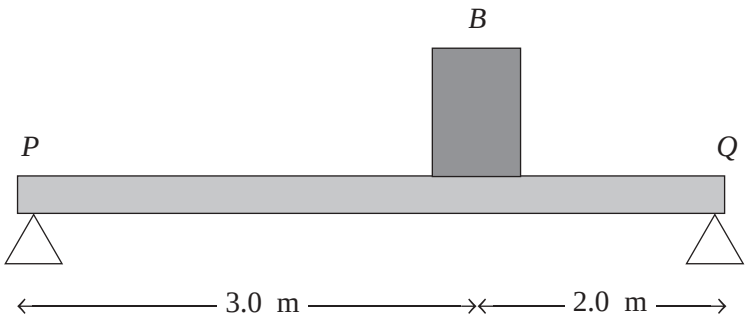
B. compressive stress.

C. both tensile and compressive stress.

D. shear stress.

Use the following information to answer Questions 10 and 11.

A 5.0 m long wooden plank of mass 200 kg is supported at ends *P* and *Q* as shown in Figure 5 below. A block (*B*) of mass of 100 kg is placed 3.0 m from point *P.*



Question 10

The magnitude of the upward reaction force at point *Q* is closest to

A. 1000 N
B. 1500 N
C. 1600 N
D. 1800 N

The mass *B* is now moved so that the upward reaction force at point *Q* is 20% larger than the upward reaction force at point *P.*

Question 11

The distance of block *B* from point *P* is now

A. 2.82 m
B. 3.00 m
C. 3.08 m
D. 3.18 m

END OF DETAILED STUDY 2

Detailed study 6 – Sound

Use the following information to answer Questions 1 and 2.

A Physics teacher places a small lit candle 10 cm in front of a loudspeaker. The loudspeaker is producing a pure sinusoidal audio sound of intensity 85 dB. The situation is shown in Figure 1.

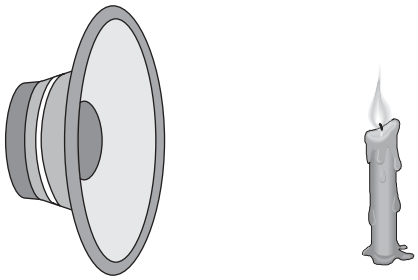


Figure 1

Question 1

When the loudspeaker produces sound the candle flame will

A. remain stationary.
B. vibrate vertically.
C. vibrate horizontally.
D. move steadily to the right.

Question 2

This experiment demonstrates that sound is a/n

A. transverse wave.
B. longitudinal wave.
C. electromagnetic wave.
D. acoustic wave.

Use the following information to answer Questions 3–5.

A flute can be modelled as a simple pipe that is open at both ends, as shown in Figure 2.

The speed of sound in a concert hall where a flautist is playing is 334 m s^{-1} and the fundamental frequency of the flute is a note of frequency 256 Hz. The length of the flute is *L*.

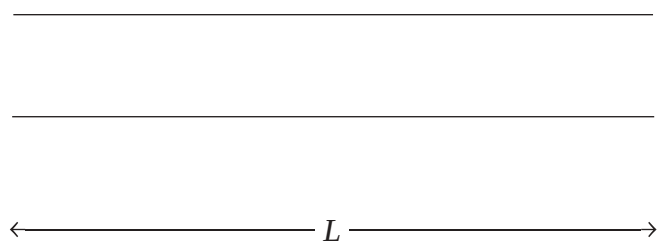


Figure 2

Question 3

The wavelength of the 256 Hz note is closest to

A. 0.15 m
B. 0.33 m
C. 0.66 m
D. 1.30 m

Question 4

The length of the flute, *L*, is closest to

A. 0.33 m
B. 0.66 m
C. 1.30 m
D. 2.60 m

Question 5

The second overtone for the flute will have a frequency of

A. 128 Hz
B. 512 Hz
C. 768 Hz
D. 1024 Hz

Use the following information to answer Questions 6 and 7.

A beach house near the ocean sits behind a sand dune as shown in Figure 3. The crashing ocean waves produce sound over the whole audio spectrum: that is, low, middle and high frequencies. Assume no sound is transmitted to the beach house through the sand dune or the ground.

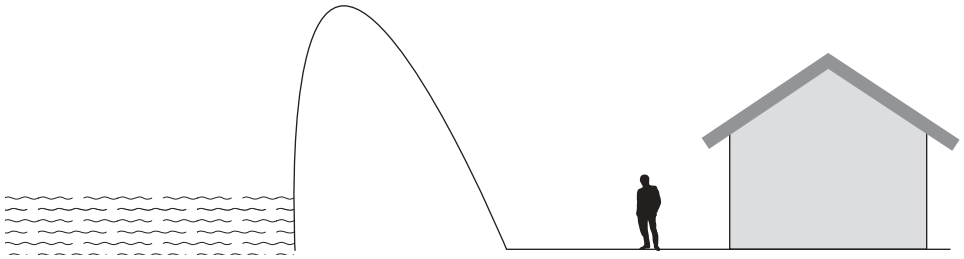


Figure 3

Question 6

Standing outside the beach house you are most likely to hear

A. only the high-frequency sounds made by the crashing ocean waves.
B. only the low-frequency sounds made by the crashing ocean waves.
C. only the middle-frequency sounds made by the crashing ocean waves.
D. both the high-frequency and the middle frequency sounds made by the crashing ocean waves.

Question 7

The reason that any sounds made by the crashing ocean waves can be heard at the beach house is because of

A. diffraction.
B. reflection.
C. refraction.
D. interference.

Use the following information to answer Questions 8–9.

A truck produces a sound intensity of 8.0×10^{-3} W m^{-2} when measured at a distance of 10 m from the truck.

Question 8

The sound intensity at a distance of 20 m from the truck is

A. 1.6×10^{-2} W m^{-2}

B. 8.0×10^{-3} W m^{-2}

C. 4.0×10^{-3} W m^{-2}

D. 2.0×10^{-3} W m^{-2}

Question 9

The decibel reading of the truck at a distance of 10 m is

A. 89 dB

B. 90 dB

C. 99 db

D. 100 dB

Question 10

Which one of the following four transducers does **not** work on the principle of electromagnetic induction and/or electromagnetic force?

A. velocity microphone

B. moving voice coil microphone

C. piezoelectric crystal microphone

D. moving voice coil loudspeaker

Question 11

Loudspeakers without baffles usually have a very poor sound quality.

This is because a baffle

A. increases constructive interference of the sound coming from the front and back of the loudspeaker.

B. decreases destructive interference of the sound coming from the front and back of the loudspeaker.

C. increases diffraction of the sound coming from the front and back of the loudspeaker.

D. decreases diffraction of the sound coming from the front and back of the loudspeaker.

END OF QUESTION AND ANSWER BOOKLET