Neap:

Trial Examination 2012

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			
1. Motion in one and two dimensions	5	5	42
2. Electronics and photonics	4	4	24
B Detailed studies			
1. Einstein's special relativity **OR**	12	12	24
2. Materials and their use in structures **OR**	12	12	24
3. Further electronics	12	12	24
			Total 90

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, up to two pages (one A4 sheet) of pre-written notes (typed or handwritten) 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 30 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 2012 VCE Physics Unit 3 Written Examination.

SECTION A – CORE

Instructions for Section A

Answer **all** questions **for both** Areas of study in this section of the paper.
Where an answer box has a unit printed in it, give your answer in that unit.
You should take the value of g to be 10 m s^{-2}.
In questions where more than one mark is available, appropriate working should be shown.

Areas of study **Page**

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Area of study 1 – Motion in one and two dimensions

Question 1

A four wheel drive (4WD) of mass 1800 kg pulls a boat on a trailer at constant speed up a boat ramp with an incline of 18°. The combined mass of the boat and trailer is 700 kg.

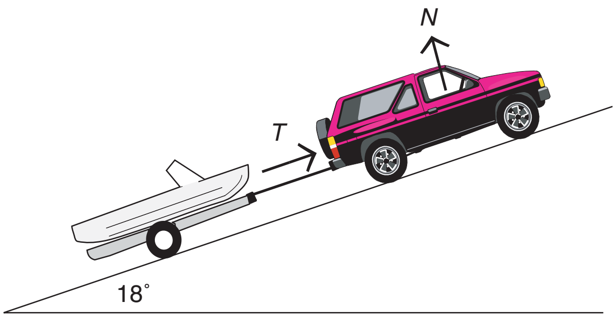

Figure 1

A frictional force of 300 N acts between the boat trailer and the ramp, and a frictional force of 850 N acts between the 4WD and the ramp.

a. Calculate the force exerted by the boat ramp on the four wheel drive, shown as *N* in Figure 1.

N

2 marks

b. Calculate the magnitude of the tension in the coupling joining the trailer and the four wheel drive, labelled *T* in Figure 1.

N

3 marks

c. Calculate the power developed by the four wheel drive if it moves the boat 15 metres up the ramp in 8.0 seconds.

W

3 marks

Question 2

Bella is investigating circular motion by swinging a pendulum constructed of a spherical mass on the end of a 0.8 m length of string, so that it moves in a circle, as shown in Figure 2. The tension in the string is 5.6 N.

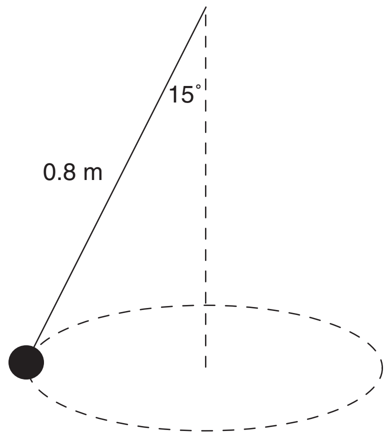

Figure 2

The string makes an angle of 15° with the vertical and Bella measures the time for 10 rotations to be 17 seconds.

a. Calculate the speed of the mass as it moves in circular motion.

$m\ s^{-1}$

3 marks

b. Calculate the mass that is on the end of the string, and hence the centripetal force acting on the mass.

mass = kg	centripetal force = N

4 marks

c. If Bella was to increase the mass on the end of the string and rotate it at the same speed and angle, which of the following would occur?

A. The centripetal force would decrease and the tension in the string would increase.

B. The centripetal force would increase and the tension in the string would decrease.

C. The centripetal force would decrease and the tension in the string would decrease.

D. The centripetal force would increase and the tension in the string would increase.

2 marks

d. Bella now uses the same equipment (with the original mass calculated in Question 5) and swings it in a vertical circle, as shown in Figure 3.

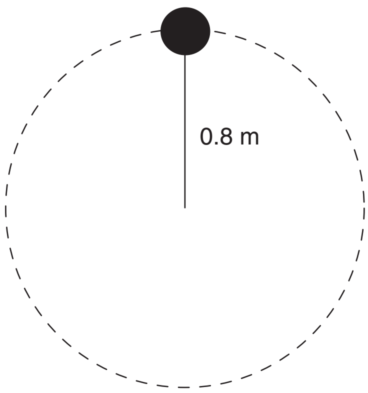

Figure 3

Calculate the minimum speed at which the mass can travel at the highest point of the circle to remain in circular motion.

m s^{-1}

2 marks

Question 3

A new toy uses a spring to launch a small rubber ball, of mass 20 g, into the air so that it can land in a basket. The launch angle can be varied. To launch the ball, the spring is compressed and the ball placed on top of it. The arrangement is shown in Figure 4.

Figure 4

When the spring is fully compressed by 8.0 cm the launch speed of the 20 g ball is 12.0 m s^{-1}. The launcher is set so that it makes an angle of 35° with the horizontal. When the launcher is set at this angle the top of the basket is 1.2 m higher than the top of the launcher. Ignore the effects of air resistance for Question 3.

a. Calculate the force constant for the spring in the launcher.

N m^{-1}

3 marks

b. Calculate the maximum height above the launcher reached by the ball if the launch angle is 35°.

m

2 marks

c. If the launch angle is 35°, at what horizontal distance from the launch point should the basket be placed so that it will catch the ball **on its way down**?

m

4 marks

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Question 4

A dodgem car of mass 600 kg (including its occupants) is travelling at 5.0 m s^{-1} East when it collides with another dodgem car travelling at 2.0 m s^{-1} West.

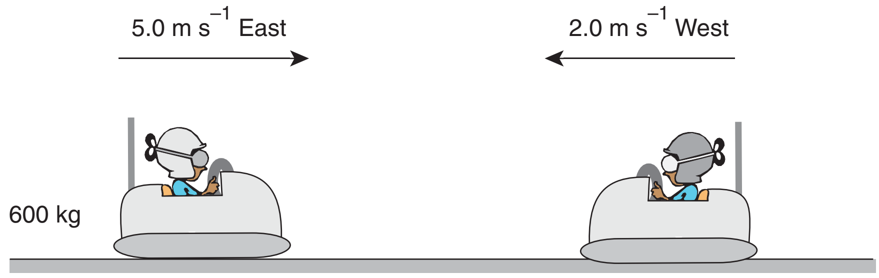


Figure 5

Immediately after the collision the two dodgem cars are locked together and move East at 1.0 m s^{-1}.

a. Calculate the mass of the dodgem car which is initially moving West.

kg

2 marks

b. If the collision between the two dodgem cars takes 0.2 seconds, calculate the magnitude of the force exerted by the West moving car on the East moving car during the collision.

N

2 marks

c. Explain, in terms of energy and work done, why the force calculated in Question 12 would be greater if the dodgem cars had rigid metal bumper bars rather than bumper bars made of rubber.

3 marks

Question 5

Mass of Mars	6.37×10^{23} kg
Radius of Mars	3.43×10^{6} m
Period of rotation of Mars	24.6 hrs
Period of Mars orbit around Sun	688 days

An artificial satellite is placed in an orbit around Mars so that it remains above the same point on the equator of Mars at all times (similar to a Geostationary orbit on Earth).

a. Calculate the orbit altitude (distance above the surface of Mars) required for the satellite to remain in this orbit.

m

3 marks

b. What is the apparent weight of the satellite when it is in this orbit? Explain your answer.

Apparent weight = N

___

___

___

2 marks

c. Calculate the gravitational field strength at the surface of Mars. You must show your working.

N kg^{-1}

2 marks

END OF AREA OF STUDY 1

Area of study 2 – Electronics and photonics

Question 1

Three 6.0 Ω resistors labelled *X*, *Y* and *Z* are connected to a 12.0 V battery as shown in Figure 1. Assume the battery has no internal resistance.

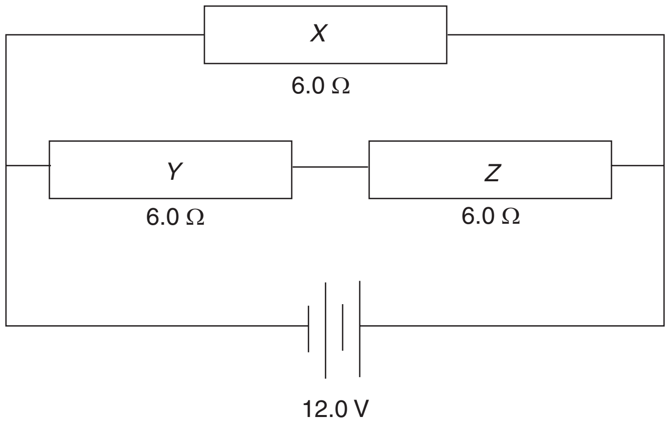


Figure 1

a. Calculate the total equivalent resistance of this circuit. Show your working.

Ω

2 marks

b. Calculate the current through resistor *Y*. Show your working.

A

2 marks

c. Calculate the power dissipated in resistor *X*. Show your working.

W

2 marks

Question 2

The diagram below (Figure 2) shows an LED in an electrical circuit.

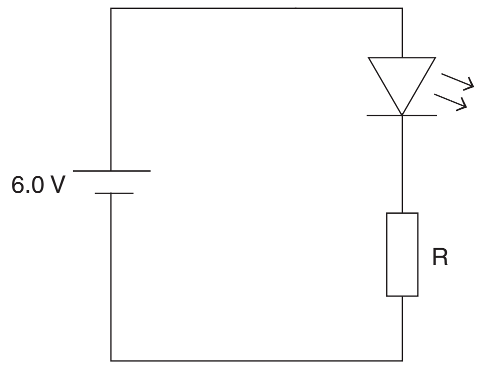


Figure 2

a. Would the LED shown in Figure 2 glow? Put YES or NO in the answer box below.

1 mark

b. Explain your answer.

1 mark

The characteristic graph for the LED is shown in Figure 3 below.

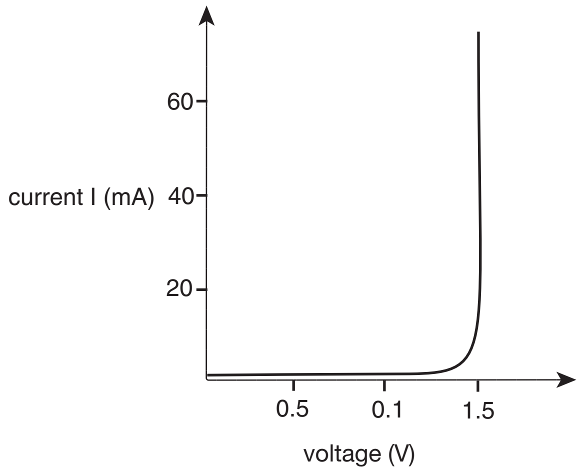


Figure 3

c. Calculate the current through the LED if the value of R is 200 Ω. Show your working.

mA

2 marks

d. The 200 Ω resistor is now replaced with a 300 Ω resistor.

As a result the LED will

A. glow less brightly than before.

B. glow with the same brightness as before.

C. glow more brightly than before.

D. cannot be determined with the information given.

2 marks

Question 3

The diagram below (Figure 4) shows the characteristic resistance–temperature graph for a thermistor in an oven.

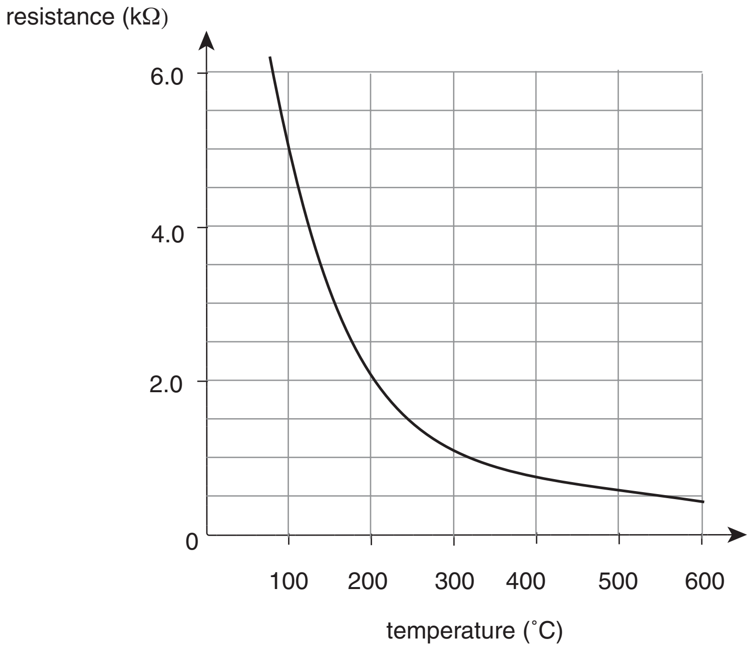


Figure 4

a. What is the value of the resistance of the thermistor when the temperature in the oven is 100 °C ?

kΩ

1 mark

b. What is the value of the resistance of the thermistor when the temperature in the oven is 400 °C ?

Ω

1 mark

Inside the oven there is a control circuit as shown in Figure 5. The variable resistor is set at 5.0 kΩ.

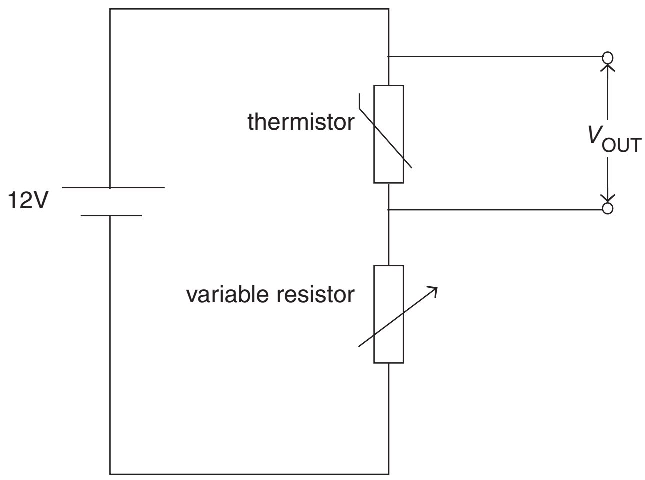


Figure 5

c. Calculate the value of V_{OUT} when the temperature in the oven is 100°C. Show your working.

V

2 marks

d. Calculate the value of the voltage drop across the variable resistor when the temperature in the oven is 400°C. Show your working.

V

2 marks

Question 4

Figure 6 shows the output voltage versus input voltage for an amplifier.

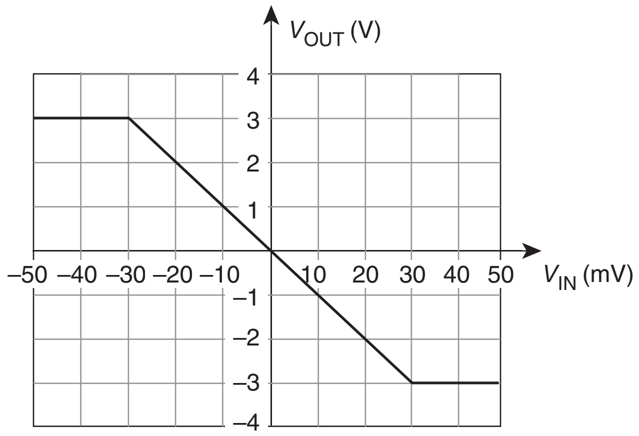


Figure 6

a. Which one of the following best represents the magnitude of the gain of the amplifier?

A. 0.10

B. 10

C. 100

D. 1000

2 marks

b. Is the amplifier an inverting amplifier or a non-inverting amplifier?

1 mark

c. The following input signal is fed into the amplifier (Figure 7).

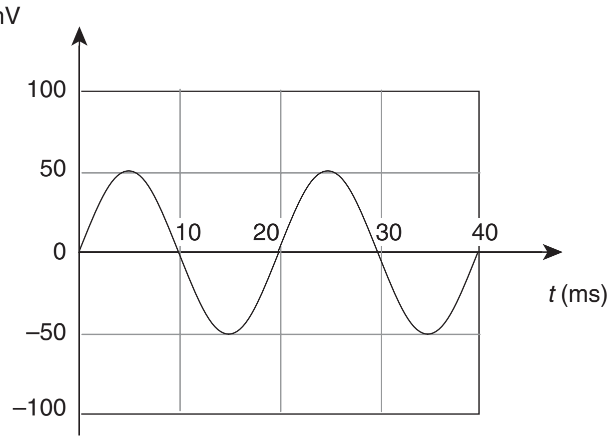
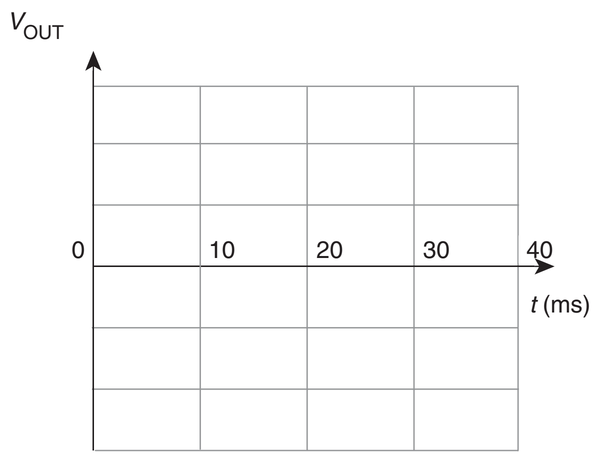


Figure 7

On the graph below draw the output voltage versus time graph and indicate the value of the output voltages on the *y*-axis.



3 marks

END OF AREA OF STUDY 2

SECTION B – DETAILED STUDIES

Instructions for Section B

Choose **one** of the following **Detailed studies**.

Answer **all** the questions on the Detailed study you have chosen.

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** 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**

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Detailed study 1 – Einstein's special relativity

Question 1

Which of the following best describes an inertial reference frame?

A. one which is absolutely stationary only
B. one which is moving with constant velocity only
C. one which is accelerating constantly
D. one which is absolutely stationary or which is moving with constant velocity

---

Question 2

A spacecraft travels past a stationary observer at a speed of 0.95c.

The γ factor is closest to

A. 0
B. 1.0
C. 1.9
D. 3.2

Question 3

The Michelson–Morley Experiment of 1887 demonstrated that

A. swimming upstream is more difficult than swimming downstream.
B. γ is constant everywhere.
C. *c* is constant everywhere.
D. gravity bends light.

Question 4

Which of the following best relates to Einstein's concept that mass can be converted to energy?

A. hydroelectric scheme
B. a nuclear power station
C. coal fired power station
D. dynamite

Question 5

A spaceship is travelling through space so that it has a γ factor of 1.10.

If the speed was increased by 50% the new γ factor would be closest to

A. 0.55
B. 1.15
C. 1.28
D. 1.65

Question 6

Proper time is best described as

A. the time recorded in the reference frame at rest with respect to the event.

B. the time recorded in the reference frame moving with respect to the event.

C. relativistic time.

D. non-relativistic time.

A proton is accelerated using a new 1.5 GeV circular particle accelerator.

Question 7

The most likely effect of the proton being accelerated is

A. it will increase its mass.

B. it will increase the amount of charge on it.

C. it will speed up so that it travels at the speed of light *c*.

D. it will become larger in size.

Question 8

As the proton travels around the 1.5 GeV circular particle accelerator, which one of the following statements explains this situation best regarding the time dilation factor for the proton?

A. The time dilation factor would be very small.

B. There would not be any time dilation factor.

C. The time dilation factor would be large.

D. There would be a time expansion rather than a time dilation.

Einstein suggested that matter and energy were related. The mass of an electron is 9.1×10^{-31} kg.

Question 9

The equivalent energy is

A. 2.8×10^{-14} J

B. 8.2×10^{-14} J

C. 8.2×10^{14} J

D. 9.1×10^{-31} J

A spacecraft of 50 m length as measured by the pilot passes a moon based observer with a relative speed near the speed of light such that the length of the spacecraft as observed from the moon observation point is 20 m.

Question 10

Which of the following best gives the γ factor for the spacecraft?

A. 0.4

B. 1.0

C. 2.5

D. 5.0

Question 11

James Clerk Maxwell in 1864 produced the following equations.

$$\nabla \times E = -\frac{\delta B}{\delta t} \qquad (1)$$

$$\nabla \cdot E = -\frac{\rho}{\varepsilon_0} \qquad (2)$$

$$\nabla \times B = \mu_0 \varepsilon_0 \frac{\delta E}{\delta t} + \mu_0 J \qquad (3)$$

$$\nabla \cdot B = 0 \qquad (4)$$

When solved, these equations demonstrated

A. electromagnetic induction.
B. electromagnetic interference.
C. electromagnetic relativity.
D. electromagnetic waves can travel at 3.0×10^8 m s^{-1}.

Question 12

One of the fundamental particles of nature is the *tau meson*. They can be created in high energy particle accelerators. One such tau meson created has a Lorentz factor of 20.

The velocity of the *tau meson* is closest to

A. 0.993749 *c*
B. 0.998749 *c*
C. 0.999749 *c*
D. 0.999949 *c*

END OF DETAILED STUDY 1

Detailed study 2 – Materials and their use in structures

The stress–strain graph for material *X* is shown in Figure 1.

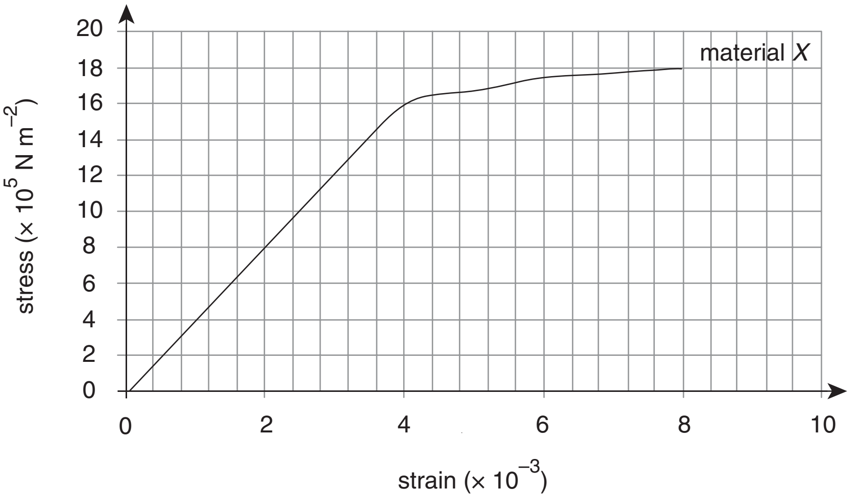


Figure 1

Question 1

The maximum tensile strength of material *X* is equal to

A. 4.0×10^3 N m^{-2}

B. 7.0×10^3 N m^{-2}

C. 1.6×10^6 N m^{-2}

D. 1.8×10^6 N m^{-2}

Question 2

From the information provided, material *X* could best be described as

A. brittle.

B. ductile.

C. tough.

D. strong.

Question 3

When a force of 1.0×10^4 N is applied to a sample of material *X*, the strain is measured to be 2.0×10^{-3}.

The cross-sectional area of the sample is equal to

A. 2.0×10^{-7} m^2

B. 1.3×10^{-2} m^2

C. 80 m^2

D. 5.0×10^6 m^2

Question 4

The value of Young's modulus for material *X* is equal to

A. 2.5×10^{-9} N m^{-2}

B. 4.0 N m^{-2}

C. 2.3×10^{8} N m^{-2}

D. 4.0×10^{8} N m^{-2}

The stress–strain graph for a second material, *Y*, is shown in Figure 2 below. Note that the graph for material *X* is also again shown on the same axes.

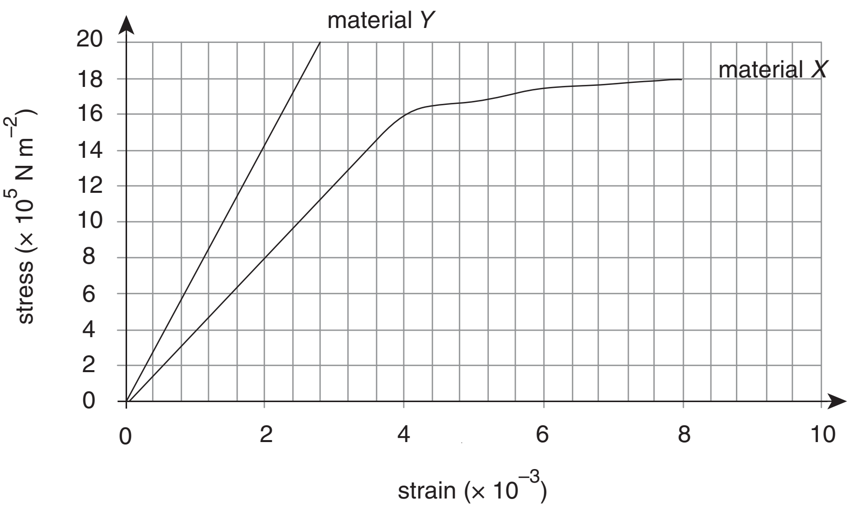


Figure 2

Question 5

Which of the following statements is correct?

A. Material *X* is tougher than material *Y* and material *Y* is stronger than material *X*.

B. Material *X* is stiffer than material *Y* and material *Y* is tougher than material *X*.

C. Material *X* is stronger than material *Y* and material *Y* is stiffer than material *X*.

D. Material *X* is tougher and stiffer than material *Y*.

Question 6

If a stress of 1.4×10^{6} N m^{-2} is applied to a 2.0 m length of material *Y*, the sample will extend by

A. 1.4×10^{-6} mm.

B. 1.0 mm.

C. 2.0 mm.

D. 4.0 mm.

A table is constructed of a table top placed on two supports, *A* and *B*, as shown in Figure 3. The mass of the table top is 20 kg and its length is 1.8 m. A 5.0 kg stack of books is placed 0.5 m from the left hand end of the table.

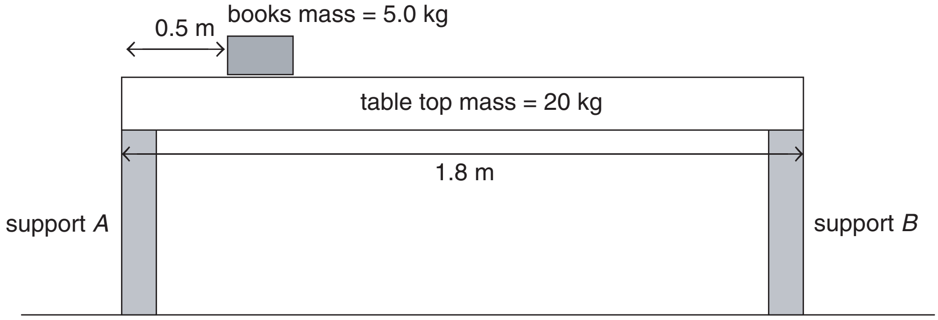


Figure 3

Question 7

The torque exerted by the books around the point where support *A* meets the table top is

A. 2.5 N m.

B. 10 N m.

C. 25 N m.

D. 50 N m.

Question 8

The upward force exerted by support *A* on the table top is equal to

A. 14 N.

B. 36 N.

C. 114 N.

D. 136 N.

Question 9

Which of the following would happen if another book was added to the pile?

A. The upward forces exerted by support *A* and support *B* on the table top would both increase.

B. The upward forces exerted by support *A* and support *B* on the table top would both decrease.

C. The upward force exerted by support *A* on the table top would increase, and the upward force exerted by support *B* on the table top would decrease.

D. The upward force exerted by support *A* on the table top would decrease, and the upward force exerted by support *B* on the table top would increase.

The 5.0 kg stack of books is now moved from the table to a shelf. The shelf is attached to the wall at point *A* shown in Figure 4, and supported by a cable *BC*, which makes an angle of 40° with the shelf. The mass of the shelf is 10 kg and its length is 1.2 m. The cable is attached to the shelf 0.9 m from the wall.

The stack of books is placed right on the end of the shelf.

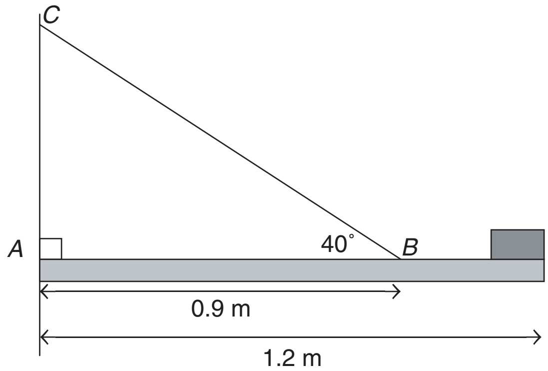


Figure 4

Question 10

Which of the following correctly describes the forces acting in the top of section *AB* of the shelf, and in the cable *BC*?

	Top of section *AB* of shelf	Cable *BC*
A.	compression	compression
B.	compression	tension
C.	tension	compression
D.	tension	tension

Question 11

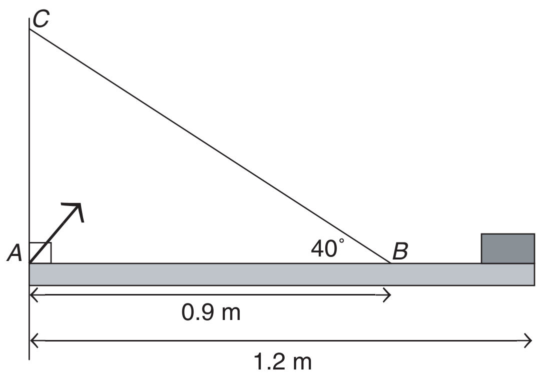
The force acting in cable *BC* is equal to

A. 21 N.
B. 174 N.
C. 207 N.
D. 233 N.

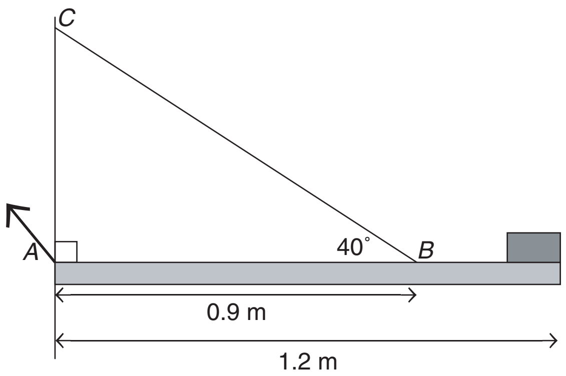
Question 12

Which of the following diagrams best represents the approximate direction of the force exerted by the wall on the shelf at point *A*?

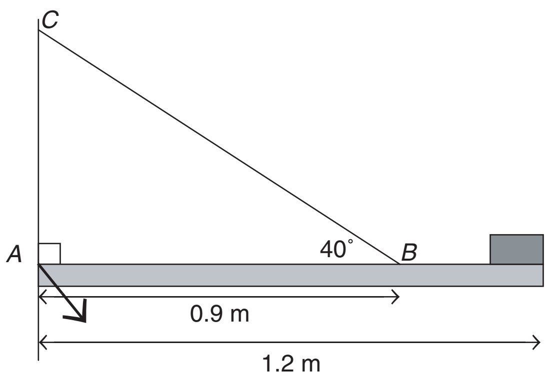
A.



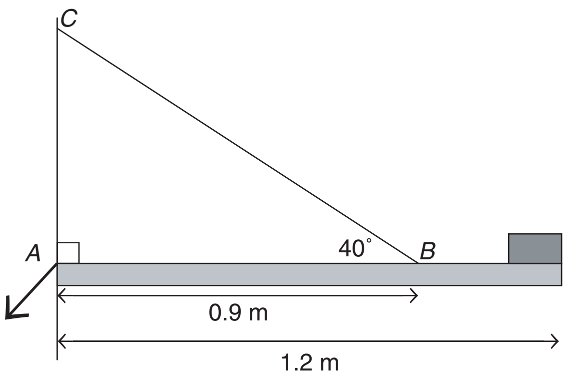
B.



C.



D.



END OF DETAILED STUDY 2

Detailed study 3 – Further electronics

Figure 1 shows a CRO trace of the mains electricity in Australia.

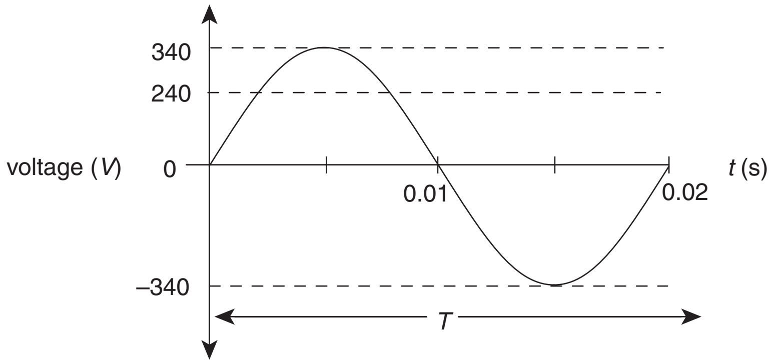


Figure 1

Question 1

The frequency of the AC voltage is

A. 10 Hz

B. 20 Hz

C. 50 Hz

D. 100 Hz

Question 2

The RMS voltage is

A. 240 V

B. 340 V

C. 480 V

D. 680 V

A step-up transformer is shown in Figure 2 below.

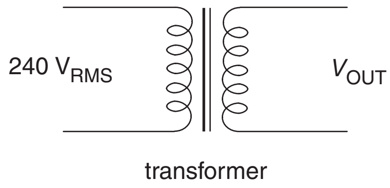


Figure 2

The transformer transforms the mains voltage to the voltage output shown below in Figure 3.

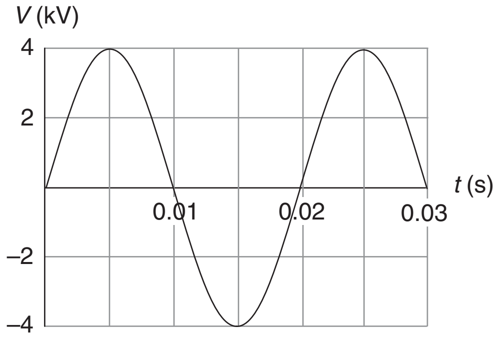


Figure 3

Question 3

The ratio of turns in the primary coils compared to the secondary coils of the transformer is closest to

A. 1:12
B. 1:17
C. 12:1
D. 17:1

The input power to the transformer is 240W.

Question 4

The RMS current in the primary coils of the transformer is

A. 0.05 A
B. 0.1 A
C. 0.5 A
D. 1.0 A

Figure 4 shows a circuit used in electronics where V_{IN} is an alternating current supply.

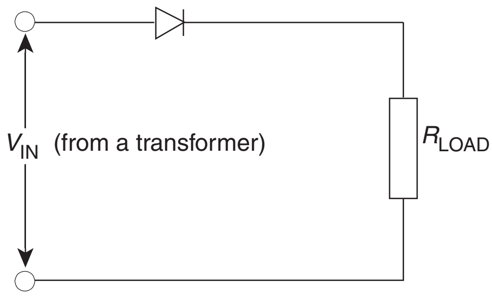


Figure 4

Question 5

The circuit shown is best described as a

A. quarter-wave rectification circuit.

B. half-wave rectification circuit.

C. three quarter-wave rectification circuit.

D. full-wave rectification circuit.

Question 6

The output voltage is not smooth enough.

One way to make it smoother would be to add

A. another resistor in series with the R_{LOAD} resistor shown

B. another resistor in parallel with the R_{LOAD} resistor shown

C. a capacitor in series with the R_{LOAD} resistor shown

D. a capacitor in parallel with the R_{LOAD} resistor shown

A 100 μF capacitor is used with a 2.0 kΩ load resistor.

Question 7

The time constant for the RC circuit is

A. 0.02 s

B. 0.2 s

C. 2.0 s

D. 20 s

Figure 5 shows a Zener diode placed in series with a resistor.

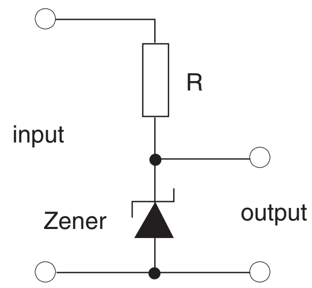


Figure 5

Question 8

The circuit shown in Figure 5 can be thought of as a simple model of a

A. rectification circuit.

B. voltage regulator.

C. current regulator.

D. smoothing circuit.

Question 9

For the circuit to work as intended the Zener diode needs to be

A. forward biased.

B. reverse biased.

C. short circuited.

D. none of the above

Figure 6 shows the current voltage characteristic graph for a voltage regulator.

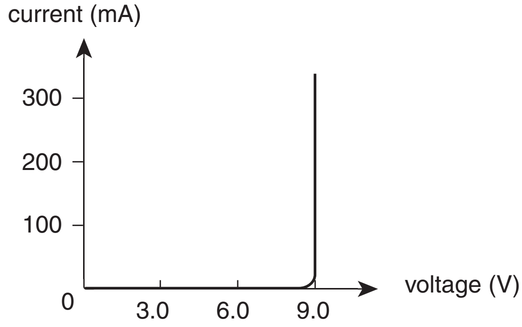


Figure 6

The voltage regulator is connected to a resistive load. The output current through the resistive load is measured at 0.15 A.

Question 10

The value of the resistive load is closest to

A. 0.15 Ω

B. 9.0 Ω

C. 30.0 Ω

D. 60.0 Ω

Figure 7 below shows the voltage versus time graph for a capacitor that is discharging.

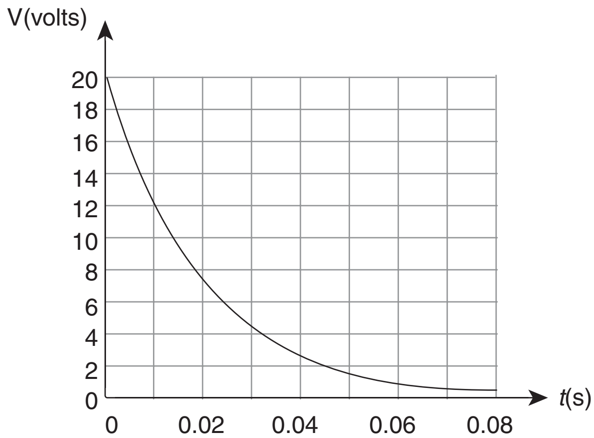


Figure 7

Question 11

The time constant for this capacitor is closest to

A. 0.01 s

B. 0.02 s

C. 0.05 s

D. 0.10 s

Heat sinks and fans are used in electronics to cool down various electronic components.

Question 12

The main purpose in removing heat from a transistor is

A. to maintain its optimum performance characteristics.

B. to warm the room.

C. to make it electrically safe.

D. none of the above

END OF QUESTION AND ANSWER BOOKLET