



VCE PHYSICS 2012

YEAR 12 TRIAL EXAM UNIT 3

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Reading Time: 15 minutes

Writing Time: 1h 30m

Structure of Booklet

Section	No of Questions	No of Questions to be answered	No of Marks
A. Core Area of Study			
1. Motion in One and Two Dimensions	18	18	40
2. Electronics and Photonics	13	13	26
B. Detailed Study			
Materials & their Use in Structures	12	12	24
Total Marks			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 a scientific calculator. Students are not permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials Supplied

Question and answers booklet with detachable data sheet.

Instructions

Detach the data sheet during reading time.

Write your name in the space provided.

Answer all questions in the question and answers booklet when indicated.

Also show your workings where space is provided.

Where an answer box has a unit printed in it, give your answer in that unit.

All responses must be in English.

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

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Data Sheet VCE Physics 2012 Year 12 Trial Exam Unit 3

1	velocity; acceleration	$v = \frac{\Delta x}{\Delta t}; a = \frac{\Delta v}{\Delta t}$
2	equations for constant acceleration	$v = u + at$ $x = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2ax$ $x = \frac{1}{2}(v + u)t$
3	Newton's second law	$F = ma$
4	circular motion	$a = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$
5	Hooke's law	$F = -kx$
6	elastic potential energy	$\frac{1}{2}kx^2$
7	gravitational potential energy near the surface of the Earth	mgh
8	kinetic energy	$\frac{1}{2}mv^2$
9	Newton's law of universal gravitation	$F = G \frac{M_1 M_2}{r^2}$
10	Gravitational field	$g = G \frac{M}{r^2}$
11	stress	$\sigma = \frac{F}{A}$
12	strain	$\varepsilon = \frac{\Delta L}{L}$
13	Young's modulus	$E = \frac{\text{stress}}{\text{strain}}$
14	AC voltage and current	$V_{RMS} = \frac{1}{2\sqrt{2}} V_{p-p} \quad I_{RMS} = \frac{1}{2\sqrt{2}} I_{p-p}$
15	voltage; power	$V = RI \quad P = VI$
16	resistors in series	$R_T = R_1 + R_2$
17	resistors in parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
18	universal gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
19	mass of Earth	$M_E = 5.98 \times 10^{24} \text{ kg}$
20	radius of Earth	$R_E = 6.37 \times 10^6 \text{ m}$

Prefixes / Units

$$p = \text{pico} = 10^{-12}$$

$$n = \text{nano} = 10^{-9}$$

$$\mu = \text{micro} = 10^{-6}$$

$$m = \text{milli} = 10^{-3}$$

$$k = \text{kilo} = 10^3$$

$$M = \text{mega} = 10^6$$

$$G = \text{giga} = 10^9$$

$$1 \text{ tonne} = 10^3 \text{ kg}$$

Student Name.....

VCE Physics 2012 Year 12 Trial Exam Unit 3

There are 12 **Multiple Choice Questions** to be answered by circling the correct letter in the table below. Use only a 2B pencil. If you make a mistake, erase it and enter the correct answer. Marks will not be deducted for incorrect answers.

SECTION B: Detailed Study 1 – Materials & their Use in Structures

<i>Question 1</i>	A	B	C	D	<i>Question 2</i>	A	B	C	D
<i>Question 3</i>	A	B	C	D	<i>Question 4</i>	A	B	C	D
<i>Question 5</i>	A	B	C	D	<i>Question 6</i>	A	B	C	D
<i>Question 7</i>	A	B	C	D	<i>Question 8</i>	A	B	C	D
<i>Question 9</i>	A	B	C	D	<i>Question 10</i>	A	B	C	D
<i>Question 11</i>	A	B	C	D	<i>Question 12</i>	A	B	C	D

VCE Physics 2012 Year 12 Trial Exam Unit 3

SECTION A – Core

Instructions for Section A
Answer all questions for both Areas of Study 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.
You should take the value of g to be 10 m s^{-2} .
Where answer boxes are provided, write your final answer in the box.
All questions are worth more than 1 mark, appropriate working should be shown.
Unless otherwise indicated, diagrams are not to scale.

Area of Study

Area of Study 1 – Motion in One and Two Dimensions.....	1
Area of Study 2 – Electronics and Photonics	9

Area of Study 1 – Motion in One and Two Dimensions

Use the following information to answer Questions 1 and 2.

There are active volcanoes all around the planet. Some of the most active on Earth are in Hawaii. Kilauea is one of the Hawaiian volcanoes that have been continuously erupting for over 25 years, allowing scientists to observe and monitor the eruptions. One scientist observes lava bombs (molten rock) being ejected vertically from the volcano with an initial velocity of 45 m s^{-1} . The mass of the lava bomb is 2.5 kg. Ignore the effects of air resistance.

Question 1

How long does it take the lava bomb to reach its maximum height?

s

(2 marks)

Question 2

Calculate the greatest height the lava bomb will obtain. Assume the lava bomb is launched from ground level.

m

(2 marks)

Use the following information to answer Questions 3 and 4.

In a collision on a busy street, a car of mass 1.2×10^3 kg travelling west at 90 km h^{-1} crashes into the back of a small truck of mass 6×10^3 kg also travelling west at 80 km h^{-1} . After impact the car and truck stick together. Disregard any friction effects.

Question 3

Determine the speed velocity of the combined vehicles.

m s^{-1}

(2 marks)

Question 4

Is this an elastic or inelastic collision? Explain your choice.

(2 marks)

An aircraft maintains a circular holding pattern of radius 500 m in a horizontal plane. The speed of the plane is 90 m s^{-1} and its mass is 8.0×10^3 kg as shown in **Figure 1**.

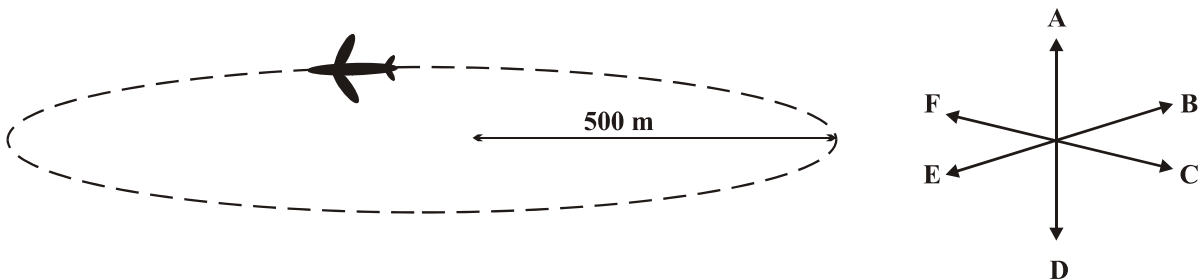


Figure 1

Question 5

Calculate the magnitude and direction of the resultant force, in kN, acting on the aircraft. Use the letters **A – F** in **Figure 1** to indicate the direction of the force acting on the aircraft when it is in the position shown.

kN: direction

(3 marks)

Use the following information to answer Questions 6 to 9.

A fireworks canister, mass 3 kg, is launched from ground level at 15 m s^{-1} and at an angle of 40° to the horizontal during a New Year's Eve celebration, as show in **Figure 2**.

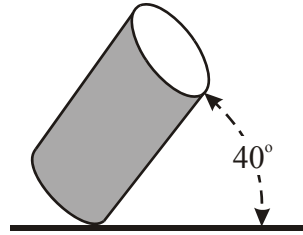


Figure 2

Question 6

Calculate the kinetic energy of the canister upon launching.

(2 marks)

Question 7

Determine the kinetic energy of the canister at the top of its path.

(2 marks)

Question 8

Determine the potential energy gained by the canister from launch to the top of its flight.

(2 marks)

Question 9

Calculate the maximum height reached by the fireworks canister.

(2 marks)

Question 11

What is the force constant of this bungee rope?

N m^{-1}

(2 marks)

Use the following information to answer Questions 12 and 13.

Figure 3 shows three carriages which are part of a train. The mass of each carriage is 84 000 kg.

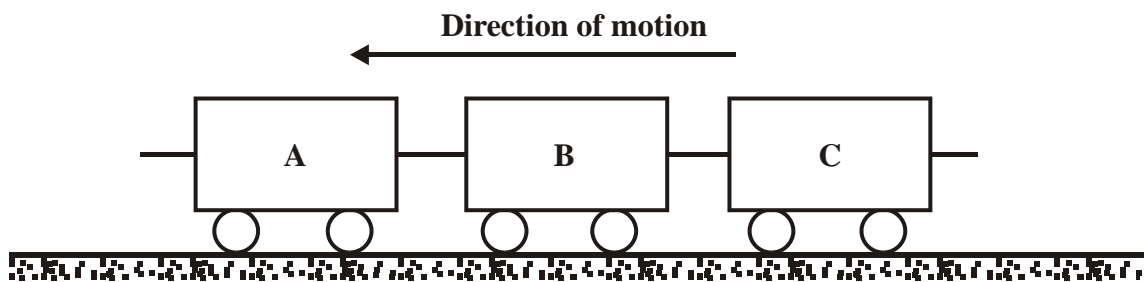


Figure 3

The train accelerates uniformly in the direction shown from rest to 16 m s^{-1} in a time of 4.0 minutes.

Question 12

Calculate the magnitude of the resultant force on each truck.

N

(2 marks)

Truck B exerts a pulling force of 11.2 kN on Truck C.

Question 13

Draw a free-body force diagram for truck B, showing the magnitudes of all the forces. Ignore any frictional forces on the trucks. Clearly identify each force as force of _____ on _____ and show the net force.

(3 marks)

The average distance of Earth from the Sun is 1.5×10^{11} m. The gravitational field strength due to the Sun at the Earth is $6.0 \times 10^{-3} \text{ N kg}^{-1}$.

Question 14

Calculate the mass of the Sun.

($G = 6.7 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$)

kg

(2 marks)

Question 15

The NASA space shuttle once travelled in an orbit that was 300 km above the surface of the Earth.

Calculate the orbital speed of the shuttle.

m s^{-1}

(2 marks)

Questions 16 and 17 refer to the following information.

Figure 4 shows a car of mass 900 kg is travelling at a constant speed of 15 m s^{-1} over a bridge. The bridge forms part of an arc of a circle. At the top of the bridge the car just loses contact with the road surface.

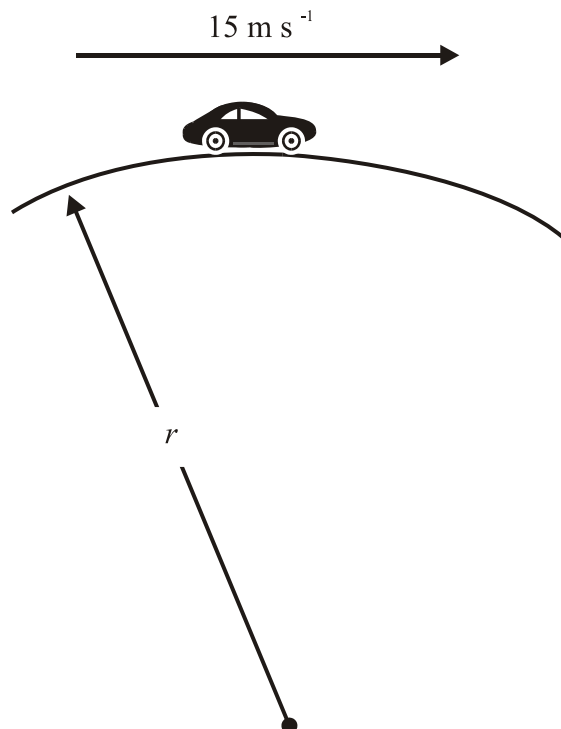


Figure 4

Question 16

Calculate the magnitude of the net force acting on the car at the top of the bridge.

(2 marks)

Question 17

Determine the radius of the bridge.

(2 marks)

According to the “Source Book For Australian Roads” 2nd Edition, curves of less than 400 m radius should be avoided on roads when a car is travelling at 100 km h^{-1} .

Question 18

Calculate the banked angle of this road for the above design speed.

(2 marks)

End of Area of Study 1

Area of Study 2 – Electronics and Photonics

Questions 1-3 refer to the following information.

Figure 1 below shows two electric lights connected in series to a 9.0 V battery. The lights have resistances R and $2R$ as indicated. The current flowing from the battery is 300 mA.

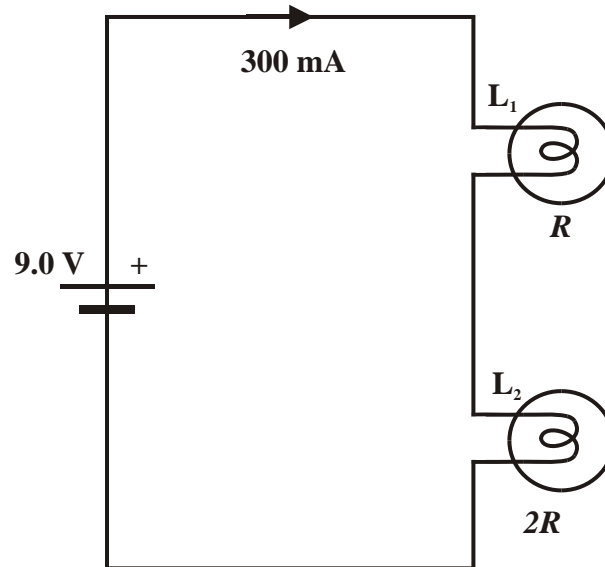


Figure 1

Question 1

Show that the voltages across the lights L_1 and L_2 are 3.0 V and 6.0 V respectively.

(2 marks)

The two electric lights are now connected in parallel, as shown below in **Figure 2**. Note that a 3.0 V battery is used in this circuit.

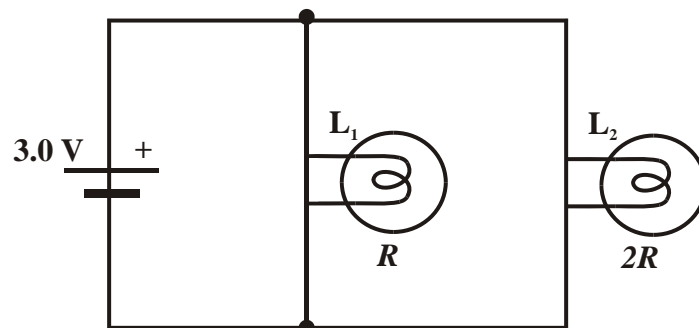


Figure 2

Question 2

Determine the current (in mA) flowing through L_2 .

(2 marks)

Question 3

Select the statement (A-D) that best compares the brightness of the light L_1 in the circuits shown in **Figures 1 and 2**.

- A. The brightness of the light L_1 in **Figure 1** is greater than that in **Figure 2**.
- B. The brightness of the light L_1 in **Figure 1** is less than that in **Figure 2**.
- C. The brightness of the light L_1 in **Figure 1** is the same as that in **Figure 2**.
- D. This cannot be determined from the information given.

(2 marks)

The resistance of a thermistor varies with temperature, as shown in **Figure 3**. The thermistor is placed into a circuit and voltage and current are recorded.

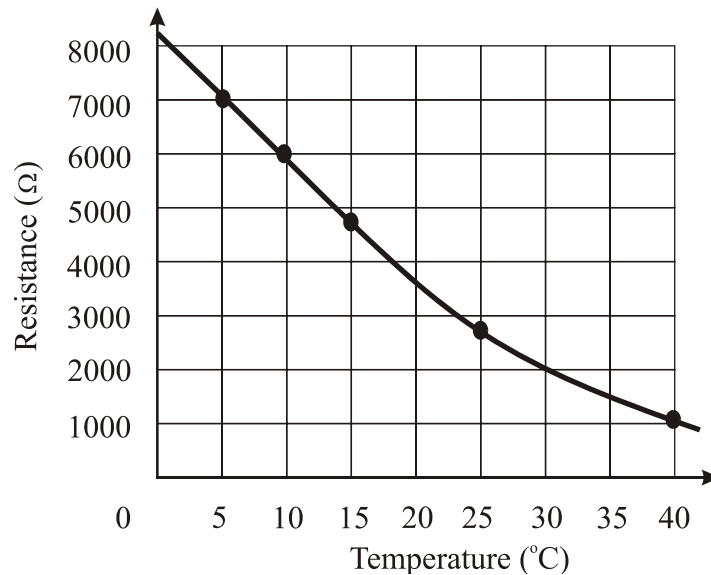


Figure 3

Question 4

The thermistor is placed into a swimming pool and the voltage measured is 6V and the current 2 mA.

What is the temperature of the pool?

°C

(2 marks)

The following information relates to Questions 5 and 6.

Amplifier characteristics

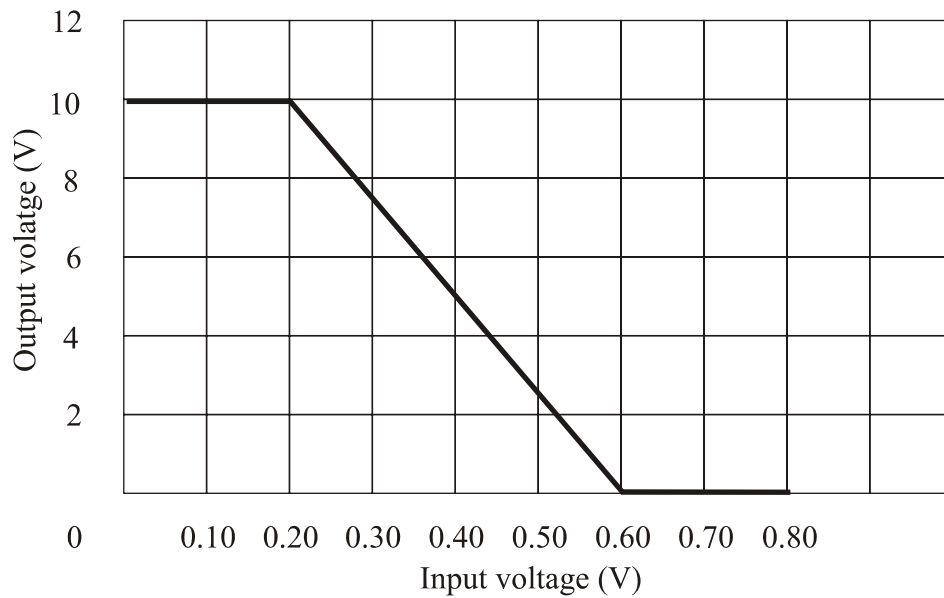


Figure 4

Question 5

Calculate the gain of this amplifier.

(2 marks)

Question 6

Is this an inverting or non-inverting amplifier?

(2 marks)

The following information relates to Questions 7 and 8.

A hair dryer has three settings, high, medium and low. These are obtained by connecting the three heating elements in parallel or in series across a 240 V mains supply. When the three elements are connected in series, the total power dissipated is 480W.

Question 7

Assuming each element has the same resistance, find the resistance of the elements when they are connected in series?

(2 marks)

Question 8

When the three elements are now connected in parallel, find the total resistance of the circuit.

(2 marks)

Question 9

Explain the difference between a non ohmic and an ohmic device.

(2 marks)

Use the following information for Questions 10, 11 and 12.

During hot weather the interior seats of a car can get dangerously hot. A student decides to make an alarm for the family car to warn them when the car seat temperature goes over a certain set value. The temperature of the seat is measured using the circuit shown in **Figure 6**. The resistance of the thermistor in the circuit as a function of temperature is also shown. The output turns on an alarm when the voltage across it is 3.0 volts or greater.

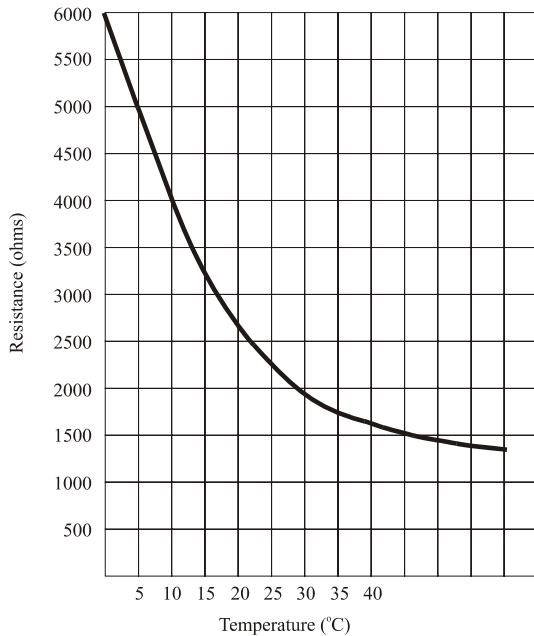


Figure 5

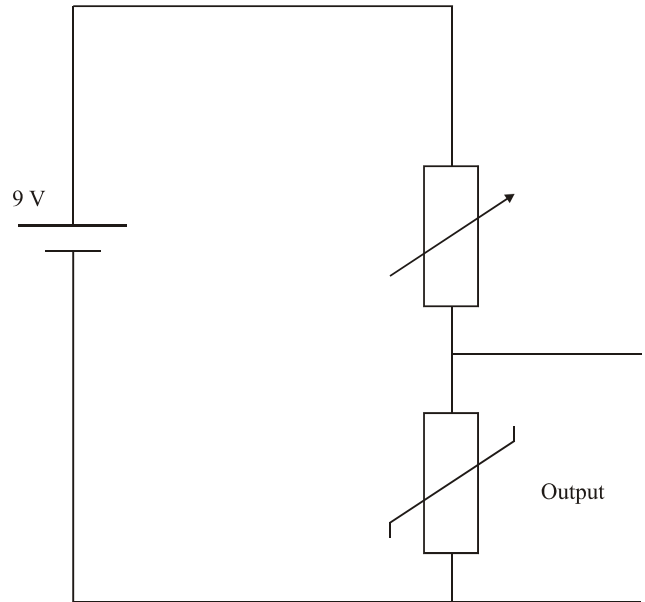


Figure 6

Question 10

What is the temperature of the seat when the resistance of the thermistor is 1500 Ω?

 ° C

(2 marks)

When the car seat temperature gets to 25 ° C, an alarm is triggered.

Question 11

What is the resistance of the variable resistor in order to turn the alarm on at 25 ° C?

 Ω

(2 marks)

Question 12

A thermistor circuit is needed as a sensor circuit for use in a fire alarm. Draw the voltage divider circuit you would use, clearly indicating where the thermistor would be.

(2 marks)

Use the information provided in **Figure 7** to answer Question 13.

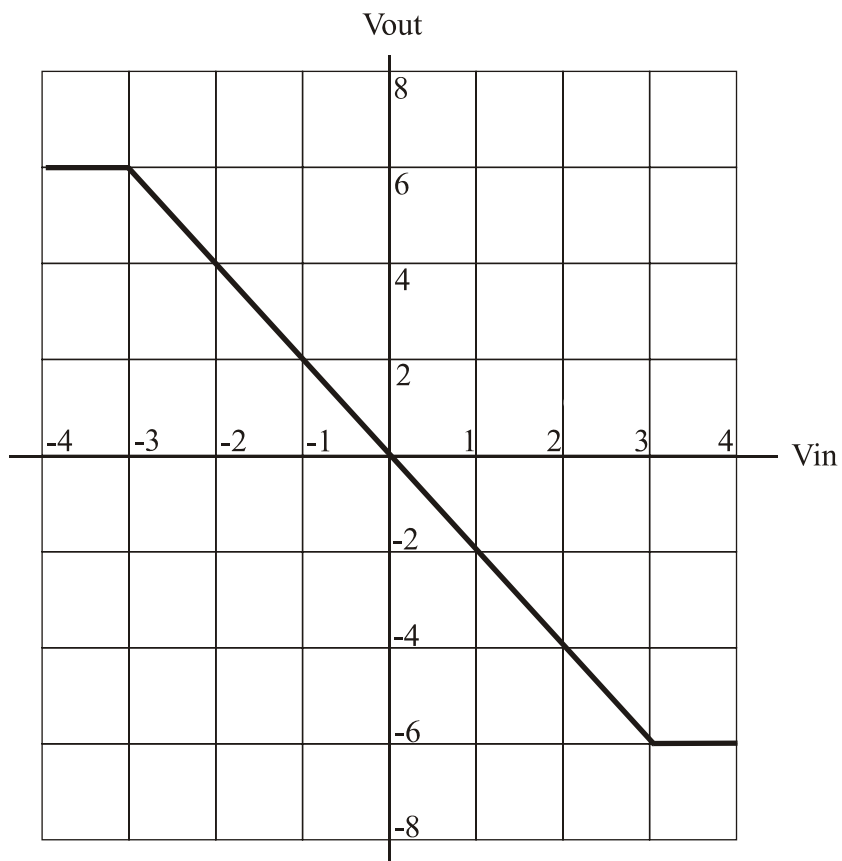


Figure 7

Question 13

Consider an amplifier whose characteristics are described by the above graph. Which of the following input signal voltages would *not* produce signal distortion in the output?

- A. 1 V
- B. 3 V
- C. 4 V
- D. 7 V

(2 marks)

End of Area of Study 2

End of Section A

SECTION B – Detailed Study

Instructions for Section B

Answer all questions from the Detailed Study, in pencil, on the answer sheet provided for multiple-choice questions.

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} .

Unless indicated, diagrams are not to scale.

Detailed Study 3.3 – Materials and their Use in Structures

The following information relates to Questions 1 and 2.

The stress-strain curves for two materials, A and B, up to their breaking points are shown below.

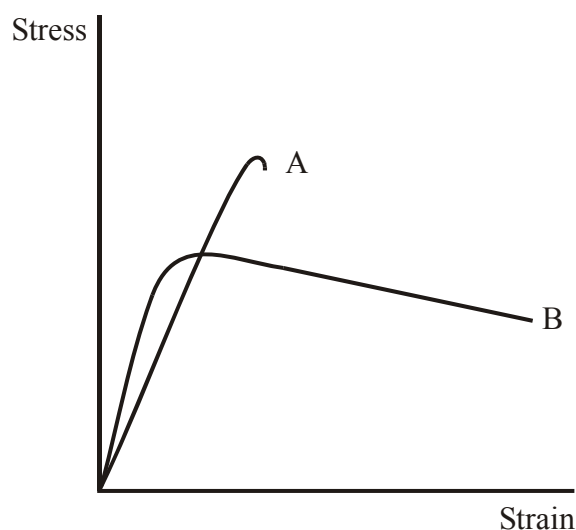


Figure 1

Question 1

The graph indicates that

- A. material A is more ductile than material B.
- B. material B is more ductile than material A.
- C. material B is stronger than material A.
- D. material A has a larger Young modulus than material B.

Question 2

The graph indicates that

- A. material B is tougher than material A.
- B. material A is tougher than material B.
- C. material B has a smaller plastic region than material A.
- D. material A is stiffer than material B.

Use the information given to answer Questions 3 – 6.

Figure 2 shows the stress-strain relationship for a 3.0 m length of copper wire under tension.

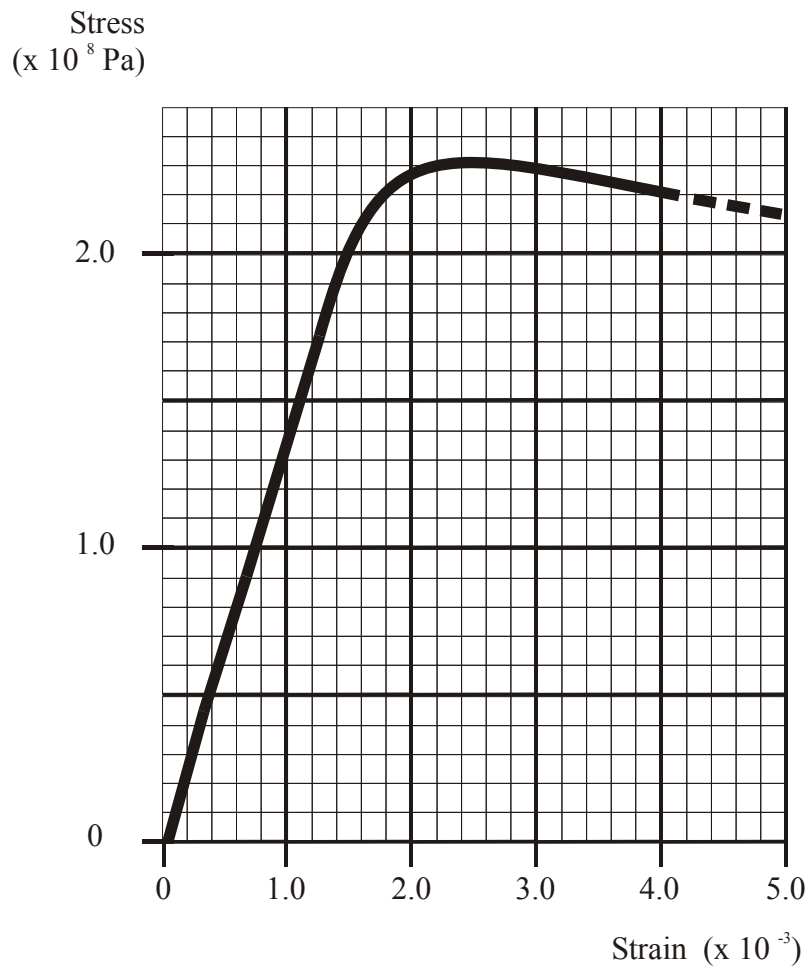


Figure 2

Question 3

The tensile strength of copper is

- A. $1.3 \times 10^{11} \text{ Pa}$
- B. $2.15 \times 10^8 \text{ Pa}$
- C. $2.3 \times 10^8 \text{ Pa}$
- D. 2.3 Pa

Question 4

The Young modulus for copper is

- A. $1.3 \times 10^5 \text{ Pa}$
- B. $1.4 \times 10^{-3} \text{ Pa}$
- C. $1.9 \times 10^8 \text{ Pa}$
- D. $1.4 \times 10^{11} \text{ Pa}$

Question 5

A copper wire of cross-sectional area $1.7 \times 10^{-6} \text{ m}^2$ and length 3.0 m is stretched by a force of 255 N.

The stress in the wire is

- A. $1.5 \times 10^8 \text{ Pa}$
- B. $1.5 \times 10^2 \text{ Pa}$
- C. $4.3 \times 10^{-6} \text{ Pa}$
- D. $4.3 \times 10^8 \text{ Pa}$

Question 6

The extension of the wire, in mm, under a load of 255 N is

- A. 1.1
- B. 3.3
- C. 0.33
- D. 0.0033

Use the information provided in **Figure 3** to answer *Question 7*.

Typical stress-strain curves for two metals, A and B, up to their breaking points are shown in **Figure 3**.

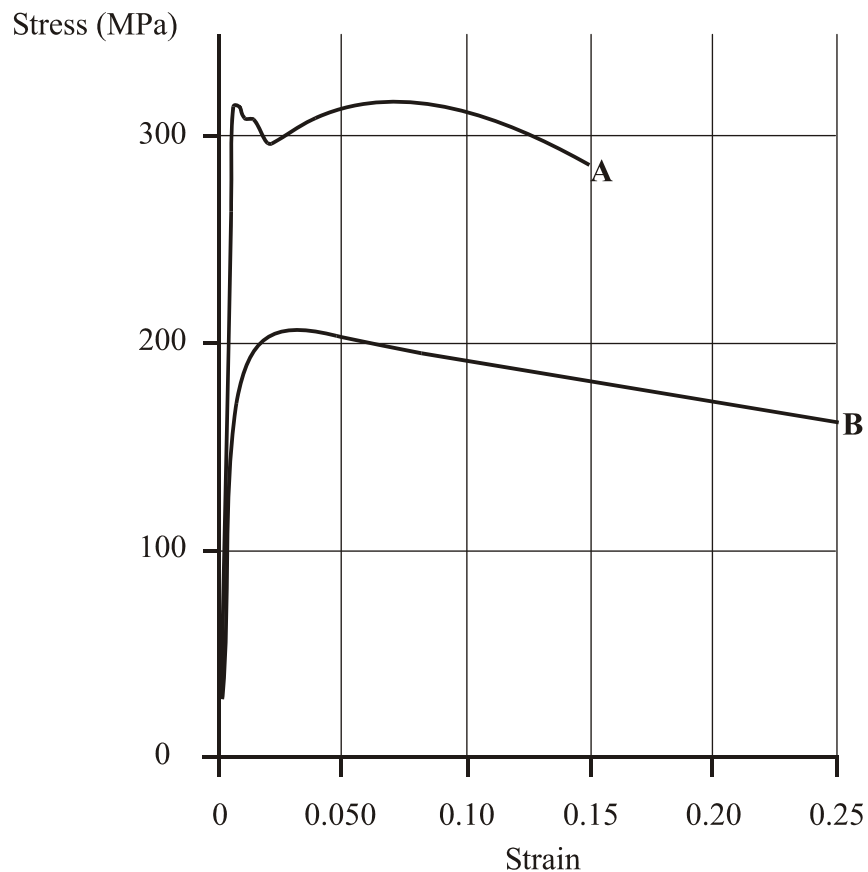


Figure 3

Question 7

The work done per unit volume in stretching material A to its breaking point is estimated to be

- A. $6.5 \times 10^7 \text{ J m}^{-3}$
 - B. 45 J m^{-3}
 - C. $4.5 \times 10^7 \text{ J m}^{-3}$
 - D. $4.5 \times 10^5 \text{ J m}^{-3}$
-

Use the information below to answer Questions 8 and 9.

Figure 4 shows a heavy truck of weight 60 kN on a bridge of mass 100 kN. The truck is stationary 30 m from the bridge support, A.

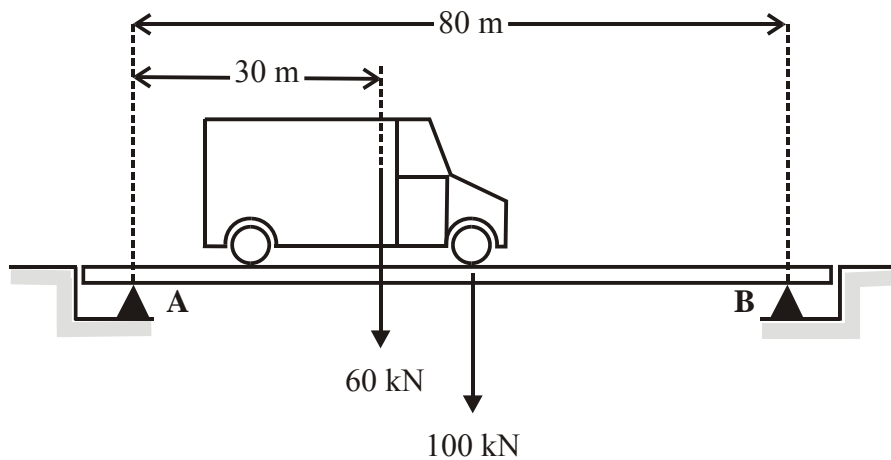


Figure 4

Question 8

The reaction force at B is closest to

- A. 160 kN
- B. 7 300 N
- C. 73 kN
- D. 16 000 N

Question 9

The reaction force at A is closest to

- A. 80 kN
- B. 40 kN
- C. 73 kN
- D. 87 kN

Figure 5 shows a horizontal concrete beam resting on two pillars, one at each end, forming a bridge. It supports a large load at its centre

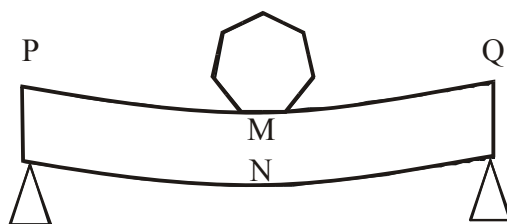


Figure 5

Question 10

The regions of the beam, labelled P, Q, M and N, that are in tension and the regions which are in compression are

- A. M is in tension and N is in compression.
- B. M and N are in compression.
- C. N is in tension and M is in compression.
- D. M and N are in tension.

Use the following information to answer Questions 11 and 12.

Figure 6 shows how the tensile strength of glass in the form of fibres depends upon the reciprocal of the cross-sectional area, A , of the fibres.

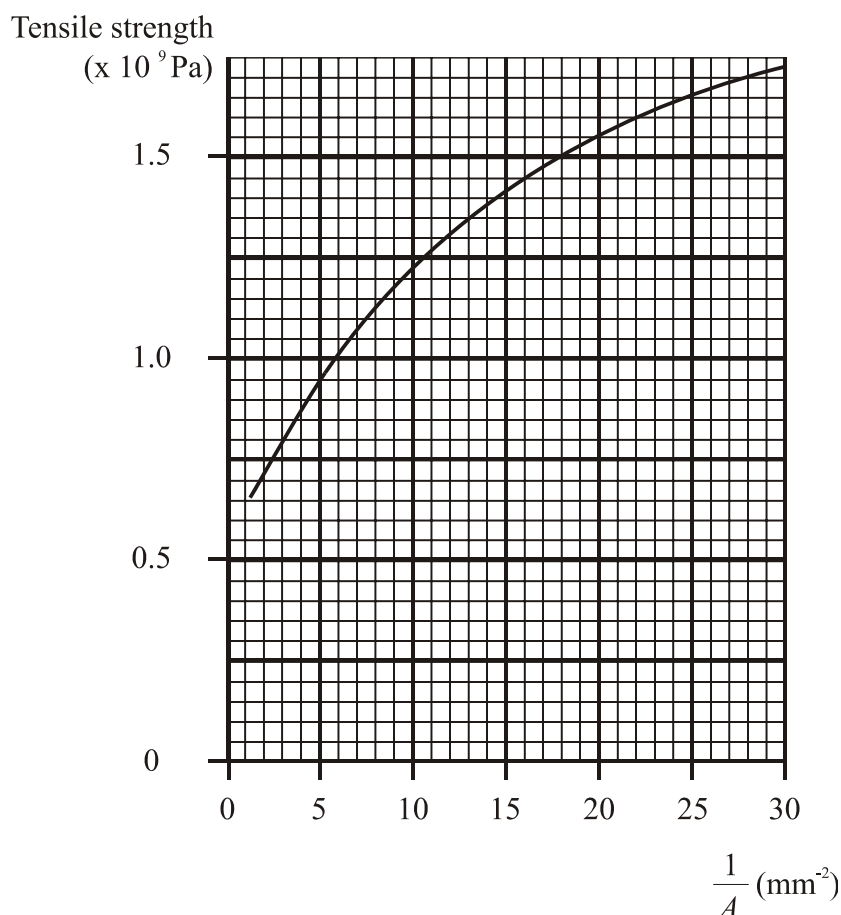


Figure 6

Question 11

Use **Figure 6** to determine that the tensile strength of a glass fibre of cross-sectional area 0.125 mm^2 is closest to

- A. $6.5 \times 10^8 \text{ Pa}$.
- B. $1.75 \times 10^9 \text{ Pa}$.
- C. $1.2 \times 10^9 \text{ Pa}$.
- D. $1.0 \times 10^9 \text{ Pa}$.

Question 12

A glass fibre of cross-section 0.125 mm^2 ($1.25 \times 10^{-7} \text{ m}^2$) has a mass of 20 kg attached to it. The glass fibre will

- A. fracture because the Young modulus is exceeded.
- B. not fracture because the tensile strength of glass is not exceeded.
- C. fracture because the tensile strength of glass is exceeded.
- D. not fracture because the Young modulus is not exceeded.

End of Detailed Study

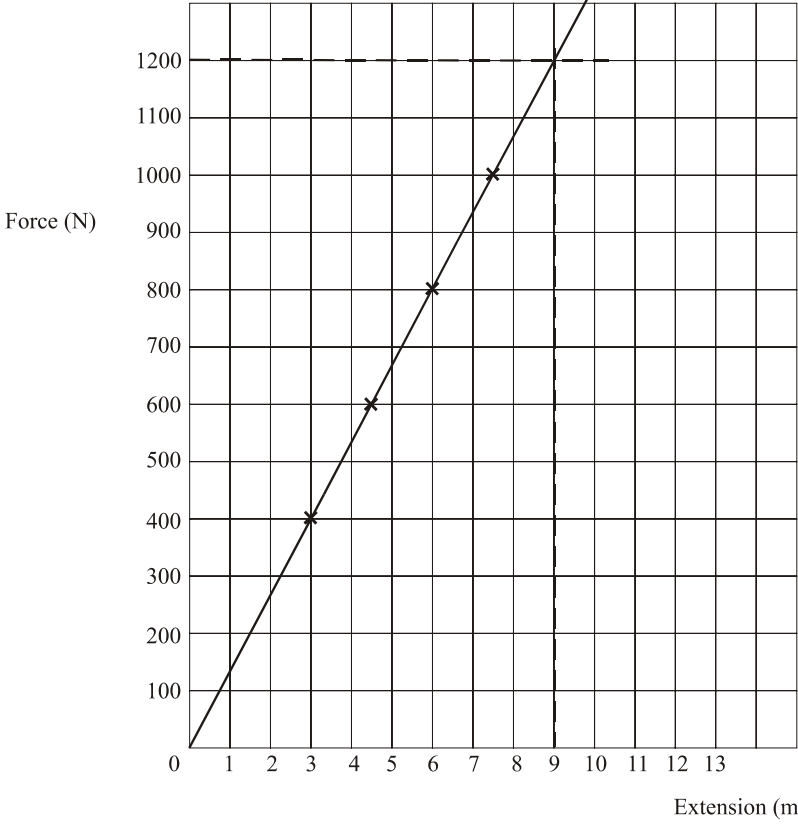
End of Trial Exam

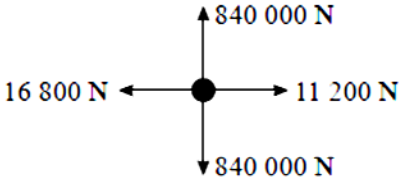
Suggested Answers

VCE Physics 2012 Year 12 Trial Exam Unit 3

SECTION A – Core

Question	Area of Study 1 – Motion in One and Two Dimensions	Marks allocated
1.	Taking up as positive $u = 45 \text{ m s}^{-1}$ $v = 0 \text{ m s}^{-1}$ $a = -10 \text{ m s}^{-2}$ $t = ?$ $v = u + at$ $0 = 45 + -10t$ $t = 4.5 \text{ sec}$	1 1
2.	$x = ut + \frac{1}{2} at^2$ $v^2 = u^2 + 2ax$ $x = 45 \times 4.5 + \frac{1}{2} (-10)4.5^2$ or $0 = 45^2 + 2(-10)x$ $x = 101.25 \text{ m}$ $x = 101.25 \text{ m}$	1 1
3.	$90 \text{ km h}^{-1} = \frac{90}{3.6} = 25 \text{ m s}^{-1}$ $80 \text{ km h}^{-1} = \frac{80}{3.6} = 22.2 \text{ m s}^{-1}$ Then using conservation of momentum $(1.2 \times 10^3 \times 25) + (6.0 \times 10^3 \times 22.2) = 7.2 \times 10^3 v$ $V = 22.7 \text{ m s}^{-1}$	1 1
4.	$KE_{\text{initial}} = \frac{1}{2} mv^2$ $= \frac{1}{2} \times 1.2 \times 10^3 \times 25^2 + \frac{1}{2} \times 6 \times 10^3 \times 22.22^2$ $= 1.9 \text{ MJ}$ $KE_{\text{final}} = \frac{1}{2} mv^2$ $= \frac{1}{2} \times 7.2 \times 10^3 \times 22.7^2$ $= 1.85 \text{ MJ}$ A loss of $5 \times 10^4 \text{ J}$ Therefore not elastic, energy transferred to heat, sound, deformation	1 1
5.	Use; $F_c = mv^2/r$ $= (8.0 \times 10^3 \times 90^2)/500$ $= 130 \text{ kN}$ The direction of the force is given by arrow C	1 1 1
6.	$E_k = \frac{1}{2} mv^2$ $= \frac{1}{2} \times 3.0 \times 15^2$ $= 337.5$ $= 340 \text{ J}$	1 1
7.	Find horizontal component of v $v_h = v \cos \theta$ $= 15 \cos 40$ $= 11.5 \text{ m s}^{-1}$ $E_k = \frac{1}{2} mv^2$ $= \frac{1}{2} \times 3.0 \times 11.49^2$ $= 200 \text{ J}$	1 1

8.	Potential energy $\Delta E_p = E_{k \text{ initial}} - E_{k \text{ at top}}$ $= 340 - 200$ $= 140 \text{ J}$	1 1
9.	$E_p = mgh = 140$ Consequential Q 8 $3.0 \times 10 \times h = 140$ $h = 4.7 \text{ m}$	1 1
10.	 <p>Force (N)</p> <p>Extension (m)</p> <p>From extrapolating graph 120 kg tourist will extend rope by 9 m (allow 8.8 to 9.2 m if read from graph) Rope will be 60 m – 1.8 – 9 = 49.2 m</p>	2 for graph 1 for (y)axis 1
11.	Gradient of graph to give the force constant of the bungee $k = 400/3.0$ $= 133.3 \text{ N/m}$ $= 130 \text{ N m}^{-1}$	1 1
12.	$u = 0, v = 16 \text{ ms}^{-1}, a = ?, t = 4.0 \times 60 = 240$ $16 = 0 + 240a$ $a = 0.067 \text{ m s}^{-1}$ $\Sigma F_c = ma$ $= 84000 \times 0.067$ $= 5600 \text{ N}$ The net force on each truck is $5.6 \times 10^3 \text{ N}$.	1 1

13.	<p>The free-body diagram for truck B should include;</p>  <p> $F_{NET} = 5600 \text{ N left}$ $F_{ConB} = 11200 \text{ N}$ $F_{AonB} = 16800 \text{ N}$ </p>	1 1 1
14.	<p>Use;</p> $g = \frac{GM_s}{R^2}$ $M_s = \frac{gR^2}{G}$ $= \frac{6.0 \times 10^{-3} \times (1.5 \times 10^{11})^2}{6.7 \times 10^{-11}}$ $= 2.0 \times 10^{30} \text{ kg}$	1 1
15.	<p>Use;</p> $R = 6.4 \times 10^6 + 3.0 \times 10^5$ $= 6.7 \times 10^6 \text{ m}$ $v = \sqrt{\frac{GM}{R}}$ $= \sqrt{\frac{6.7 \times 10^{-11} \times 6.0 \times 10^{24}}{(6.7 \times 10^6)}}$ $= 7.7 \times 10^3 \text{ ms}^{-1}$	1 1
16.	<p>At the top of the bridge, the only physical force acting on the car is gravity, so this must be the net force.</p> $\Sigma F = mg$ $= 900 \text{ kg} \times 10 \text{ N kg}^{-1}$ $= 9.0 \times 10^3 \text{ N}$	1 1
17.	$\Sigma F = \frac{mv^2}{r}$ <p style="text-align: right;">[conseq Q16]</p> $r = \frac{mv^2}{\Sigma F}$ $= \frac{900 \times (15)^2}{9.0 \times 10^3}$ $= 23 \text{ m}$	1 1
18.	$r = 400 \text{ m}$ $g = 10$ $v = 100/3.6 = 27.8 \text{ m s}^{-1}$ $\tan \theta = v^2/gr$ $\tan \theta = 27.277^2/10 \times 400$ $\tan \theta = 0.19$ $\theta = 10.9^\circ$	1 1

Question	Area of Study 2: Electronics and Photonics	Marks Allocated
1.	Voltage divider L2 has double the resistance and so the PD across it is double that of L1. 9V is divided in the ratio 1:2 for L1: L2 Therefore PD across L1 is 3V and PD across L2 is 6V.	1 1
2.	From Q1, 300 mA flows through L1 when PD is 3.0 V. In Fig 2, L1 has 3.0 V across it so current is 300 mA through L1. L2 has double resistance of L1 so current must be half that of L1. So current through L2 = $300/2 = 150$ mA	1 1
3.	C is correct response. The current is 300 mA for L1 in both circuits and the PD across L1 is 3.0V in both, so power $P=IV$ is equal (900mW).	2
4.	$V = IR$ $6.0 = 0.0020 \times R$ $R = 3000\Omega$ From graph temperature is $\approx 23^\circ \text{C}$	1 1
5.	Gain = $\Delta v_{\text{out}}/\Delta v_{\text{in}}$ = $10/0.40$ = 25	1 1
6.	From graph inverting	2
7.	$R_{\text{total}} = V^2/P$ $R_t = 240^2/480$ $R_t = 120\Omega$ Each element 40Ω	1 1
8. [conseq Q7]	$1/R_{\text{total}} = 1/R_1 + 1/R_2 + 1/R_3 = 1/40 + 1/40 + 1/40$ $R_t = 13 \Omega$	1 1
9.	An ohmic device obeys Ohm's law: $V = IR$. An ohmic device has a constant resistance, regardless of the applied voltage. A non-ohmic device does not have a constant resistance, since the value of its resistance varies with the value of the applied voltage. Or linear graph originating from the origin for ohmic.	1 1
10.	From graph 45°C	2
11.	25°C $R = 2250 \Omega$ $V_{\text{out}} = \frac{R_{\text{out}}}{R_{\text{out}} + R_{\text{in}}} \times V_{\text{in}}$ $3.0 = \frac{2250}{2250 + R_{\text{in}}} \times 9.0$ $R_{\text{in}} = 4500 \Omega$	1 1
12.	Need a circuit to deliver high voltage when hot conditions are detected. The voltage divider circuit will have the thermistor at the top.	2
13.	A , 1.0 V it's inside the linear range of the amp.	2

SECTION B – Detailed Study

Question	Detailed Study: Materials and their Use in Structures
1.	Answer B Material B is more ductile than material A.
2.	Answer A Material B is tougher than material A.
3.	Answer C Tensile strength = 2.3×10^8 Pa : largest stress value
4.	Answer D Use; $Y = \frac{\text{stress}}{\text{strain}}$ $= \frac{1.9 \times 10^8}{1.4 \times 10^{-3}}$ $= 1.4 \times 10^{11} \text{ Pa}$
5.	Answer A Use; $\text{stress} = \frac{\text{force}}{\text{area}}$ $= \frac{255}{1.7 \times 10^{-6}}$ $= 1.5 \times 10^8 \text{ Pa}$
6.	Answer B From the graph, the strain is 1.1×10^{-3} when the stress is 1.5×10^8 Pa Use; $\text{strain} = \frac{\Delta L}{L}$ $\Delta L = 3.0 \times 1.1 \times 10^{-3} \text{ m}$ $= 3.3 \times 10^{-3} \text{ m}$ The extension of the wire is 3.3 mm.
7.	Answer C The work done is estimated from the area under the graph; For material A; $\text{area} = 300 \times 10^6 \times 0.15$ $= 4.5 \times 10^7 \text{ J m}^{-3}$

8.	<p>Answer C</p> <p>Take torques about A; $\Sigma \tau_{CW}$ about A; $= (60 \times 30) + (100 \times 40) = 5800 \text{ kN m}$</p> <p>$\Sigma \tau_{ACW}$ about A; $= 80 \times F_B \text{ kN m}$</p> <p>$\Sigma \tau_{CW} = \Sigma \tau_{ACW}$ $80 \times F_B = 5800$</p> <p>$F_B = \frac{5800}{80} = 73 \text{ kN}$</p>
9.	<p>Answer D</p> <p>Use; $F_A + F_B = 160 \text{ kN}$ $F_B = 73 \text{ kN}$ $F_A = 160 - 73$ $= 87 \text{ kN}$</p>
10.	<p>Answer C</p> <p>N is in tension and M is in compression.</p>
11.	<p>Answer D</p> <p>As $A = 0.125 \text{ mm}^2$ then $\frac{1}{A} = 8.0 \text{ mm}^{-2}$</p> <p>Use the graph to determine tensile strength for this value. Tensile strength $\approx 1.1 \times 10^9 \text{ Pa} \rightarrow 1.15 \times 10^9 \text{ Pa}$</p>
12.	<p>Answer C</p> <p>Calculate the stress; $\sigma = \frac{F}{A}$ $= \frac{20 \times 10}{1.25 \times 10^{-7}}$ $= 1.6 \times 10^9 \text{ Pa}$</p> <p>This exceeds the value calculated in q 11.</p>

End of Suggested Answers