VCE PHYSICS 2010

YEAR 12 TRIAL EXAM UNIT 3

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 & Two Dimensions	18	18	40
2. Electronics & Photonics	10	10	24
B. Detailed Study			
1. Materials & their use in Structrues	13	13	26
		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 2010 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	$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}
19	mass of Earth	$M_E = 5.98 \times 10^{24}$ kg
20	radius of Earth	$R_E = 6.37 \times 10^6$ m

Prefixes / Units

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

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

μ = micro $= 10^{-6}$

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

k = kilo $= 10^{3}$

M = mega $= 10^{6}$

G = giga $= 10^{9}$

1 tonne $= 10^{3}$ kg

Student Name: ……………………………………………………………………………

VCE Physics 2010 Year 12 Trial Exam Unit 3

Instructions: use a **PENCIL** for **ALL** entries. For each question, shade the box that indicates your answer.

All answers must be completed like **THIS** example.
Marks will **NOT** be deducted for incorrect answers.

A	B	C (shaded)	D

NO MARK will be given if more than **ONE** answer is completed for any one question.
If you make a mistake, **ERASE** the incorrect answer – **DO NOT** cross it out.

SECTION B: Detailed Study 3.3 – Materials & their use in Structures

One answer per line

1	A	B	C	D	**2**	A	B	C	D
3	A	B	C	D	**4**	A	B	C	D
5	A	B	C	D	**6**	A	B	C	D
7	A	B	C	D	**8**	A	B	C	D
9	A	B	C	D	**10**	A	B	C	D
11	A	B	C	D	**12**	A	B	C	D
13	A	B	C	D					

VCE Physics 2010 Year 12 Trial Exam Unit 3

Core – Section A

Instructions for Section A
*Answer **all** questions **for both** Areas of study in this section in the spaces provided.*
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 $^{-2}$.

Areas of Study

Area of Study 1 – Motion in One and Two Dimensions

A person of mass 70 kg is sitting in a car travelling horizontally with an acceleration of 3.0 m s $^{-2}$.

Question 1
Calculate the magnitude of the gravitational force acting on the person.

N

(2 marks)

Shortly after leaping from an aeroplane, and before releasing his parachute, an 80 kg skydiver experiences a vertical upward force of 200 N exerted on him due to air resistance.

Question 2
Calculate the magnitude of the acceleration of the person at this instant.

ms $^{-2}$

(2 marks)

Questions 3 to 6 refer to the following information.

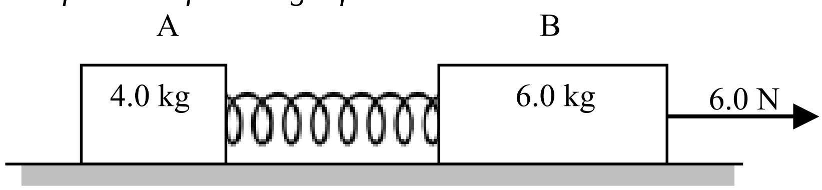


Figure 1

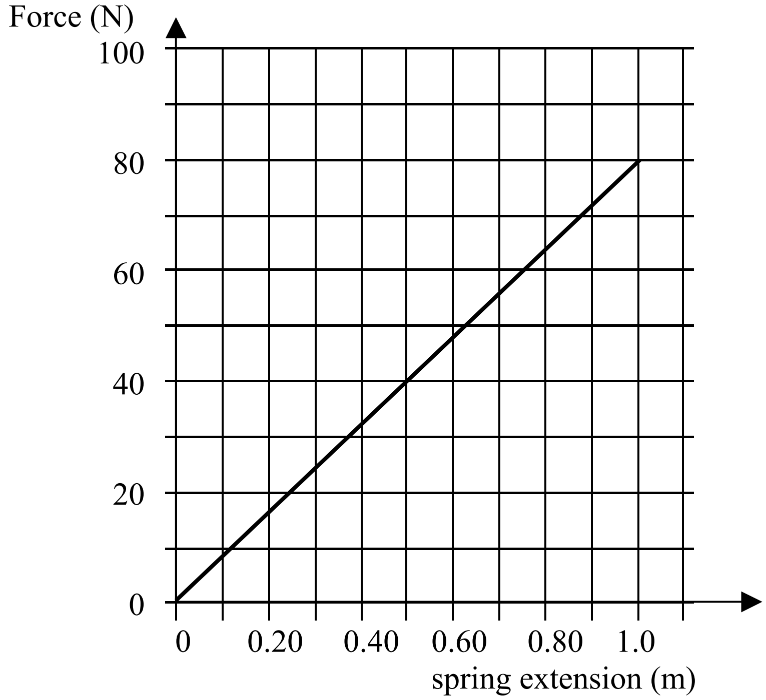


Figure 2

Block A of mass 4.0 kg and block B of mass 6.0 kg are connected as shown in **Figure 1** by a spring of negligible mass. The system is being pulled to the right across a horizontal smooth surface by a horizontal force of 6.0 N, with both blocks experiencing equal constant acceleration.

The force-extension characteristics of the spring are shown in **Figure 2**.

Question 3

Use **Figure 2** to calculate the spring constant.

$N\ m^{-1}$

(2 marks)

Question 4
Calculate the magnitude of the force exerted by the spring on the 4.0 kg block.

N

(2 marks)

Question 5
Calculate the extension of the spring as the system moves with constant acceleration.

m

(2 marks)

Question 6
Calculate the magnitude of the strain potential energy of the spring when it is extended during this constant acceleration.

J

(2 marks)

A baseball batter hits a ball with a speed of 45 m s $^{-1}$ at an angle of 25^0 above the horizontal, toward the boundary fence, a distance of 130 m away. The ball was 1.0 m above the ground when hit. **Figure 3** represents the information. If the ball clears the boundary fence, 3.0 m high, the batter is awarded a home run.

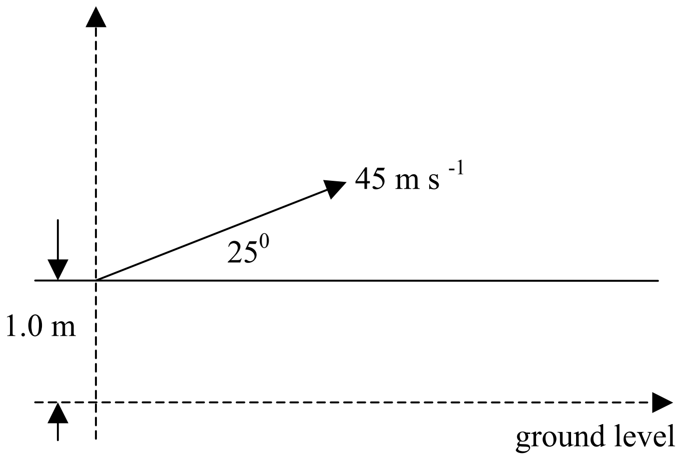
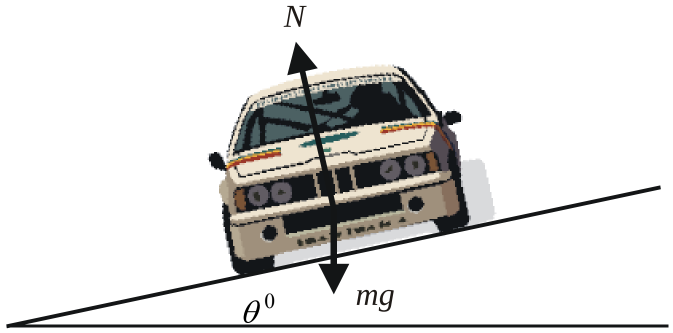


Figure 3

Question 7
State whether or not the batter is awarded a home run and support your answer with calculations.

(4 marks)

Traffic is expected to move around a curve of radius 200 m at a speed of 25 m s $^{-1}$. **Figure 4** shows the normal reaction of the road on the car *N*, the weight of the car, *mg,* the banking angle of the road θ^0 so that there is no dependence placed on friction.



(not to scale)

Figure 4

Question 8

Calculate the value of angle, θ, in degrees, if no dependence is to be placed on frictional forces.

degrees

(2 marks)

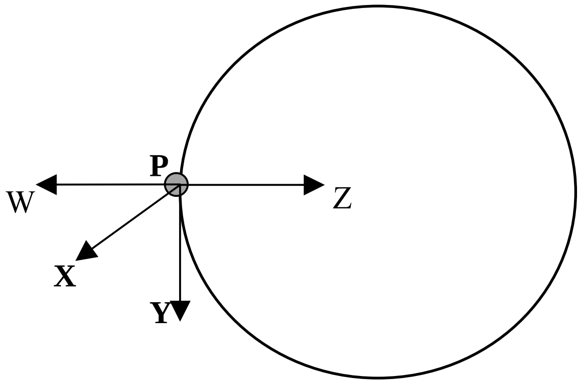
The design engineer of a roller coaster wishes passengers to experience ‘weightlessness’ as they round the top of one of the hills that has a radius of curvature of 20 m.

Question 9
Calculate the speed of the roller coaster required for passengers to experience ‘weightlessness’ as they pass the top of the hill.

m s^{-1}

(2 marks)

An object moves in uniform circular motion, in an anticlockwise direction, in a vertical plane.
Question 10
Which one of the directions, W – Z, gives the direction of the acceleration at point P?



(2 marks)

A space station is constructed in the form of a rotating wheel of diameter 150 m. Space engineers are required to regulate the spin of the station, so that the acceleration produced at the rim of the space station will be 1.6 m s^{-2}.

Question 11
Calculate the required period of rotation, in s, of the space station to attain this acceleration.

s

(2 marks)

The space shuttle orbits the Earth at an altitude of 400 km above the surface. A new satellite, of mass 900 kg, is deployed, and this satellite is to orbit a further 300 km away from the Earth.

Question 12

Use the graph shown in **Figure 5** to estimate the work required to deploy the satellite to its new orbit.

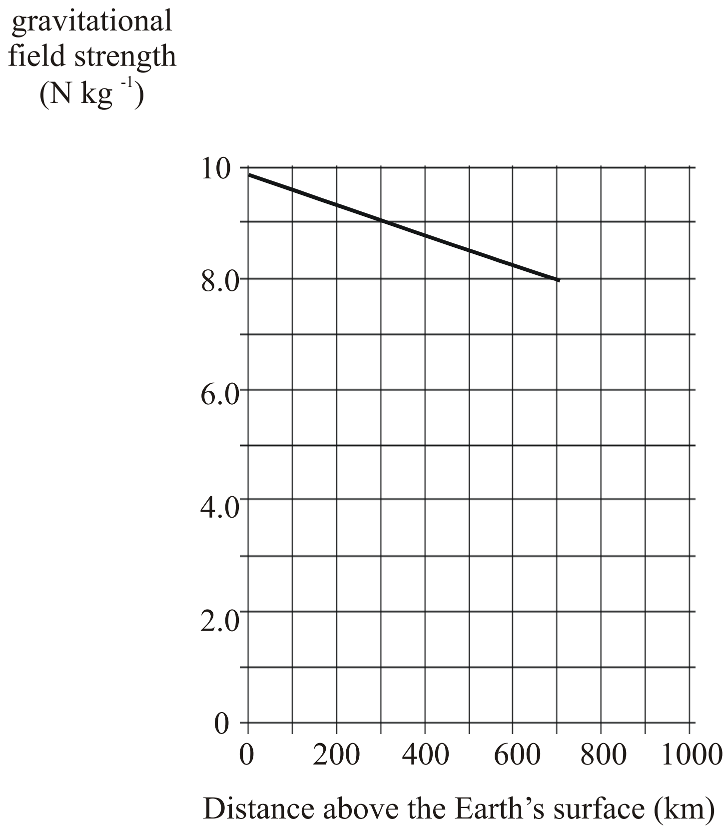


Figure 5

(2 marks)

A meteor passes by a moon as shown in **Figure 6**. Starting at position 1, the meteor moves past the moon through position 2 to position 3.

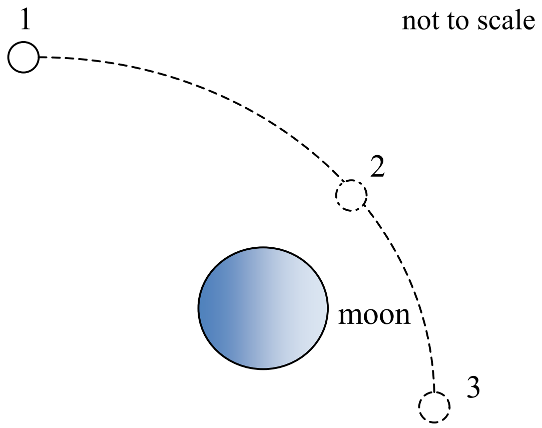
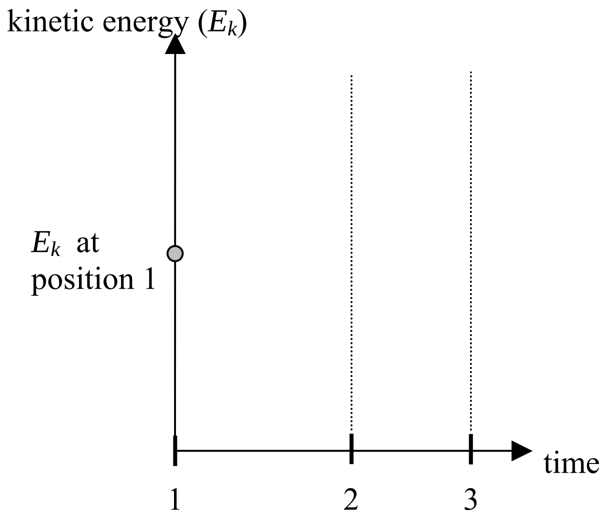


Figure 6

Question 13

On the axes below, sketch a possible kinetic energy – time graph that shows how the kinetic energy of the meteor changes from position **1** to position **3.** Justify your answer.



____

____

(3 marks)

Figure 7 shows a small section of how the gravitational field strength varies with the ***reciprocal of the square*** of the distance from the centre of a planet.

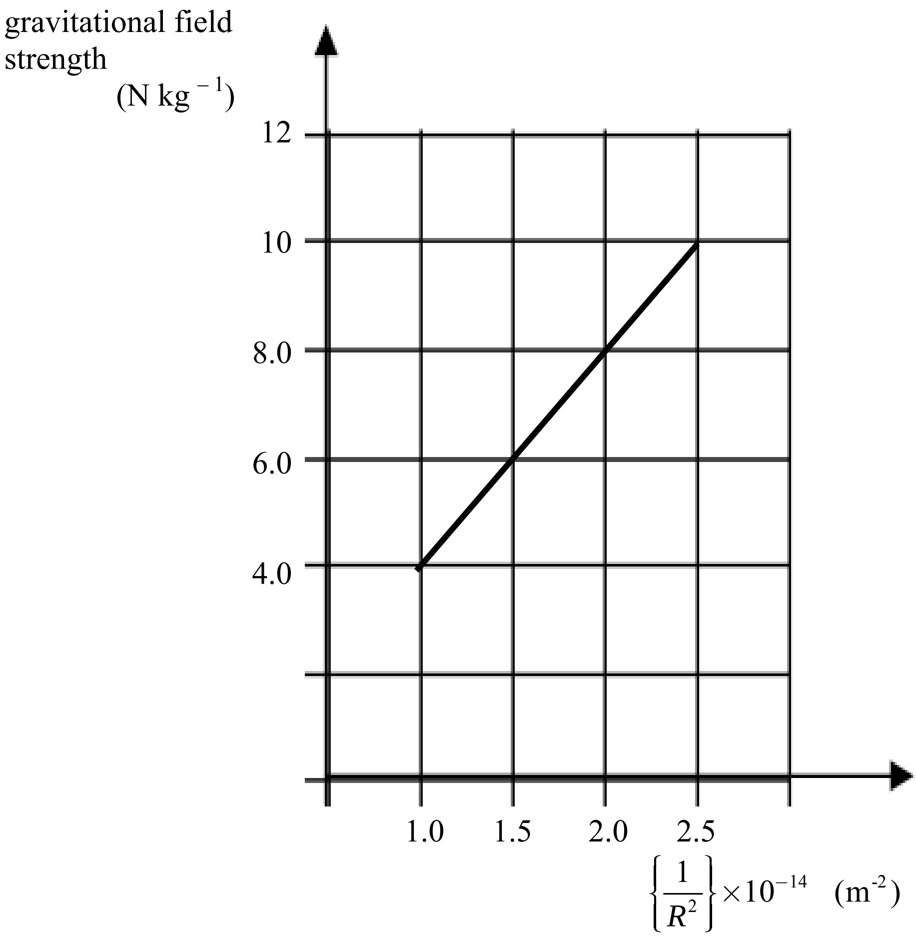


Figure 7

Question 14
Use **Figure 7** to calculate the mass of the planet.

(2 marks)

Questions 15 to 18 refer to the following information.

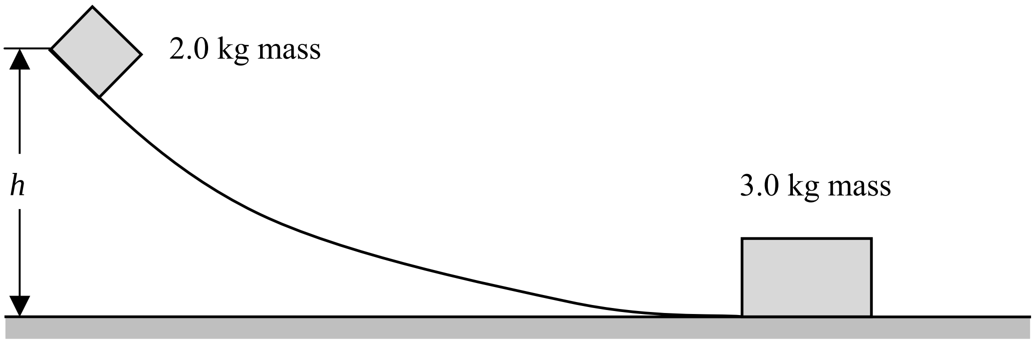


Figure 8

A small block of mass 2.0 kg is released from rest at the top of a smooth curved ramp as shown in **Figure 8**. The block slides down the ramp and is moving with a speed of 3.5 m s $^{-1}$ when it collides with a larger block of mass 3.0 kg at rest on a rough horizontal surface at the bottom of the incline. The larger block moves to the right at a speed 2.0 m s $^{-1}$ immediately after the collision.

Question 15

Calculate the height, *h,* of the ramp from which the small block was released.

m

(2 marks)

Question 16
Calculate the speed of the small block immediately after the collision.

m s $^{-1}$

(2 marks)

The larger block slides a distance 0.50 m before coming to rest.
Question 17
Calculate the magnitude of the frictional force that brings the larger block to rest.

N

(2 marks)

Question 18
Use a calculation to determine whether the collision between the two blocks is elastic or inelastic and state your result clearly.

____

____

(3 marks)

Area of Study 2 – Electronics and Photonics

Questions 1 and 2 refer to the following information.
Figure 1 shows two parallel identical lamps connected to a resistor, R, and a 12 V battery.

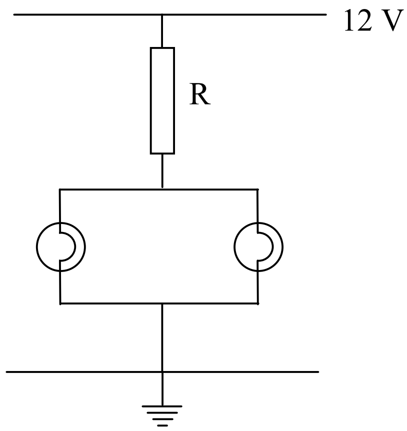


Figure 1

Each lamp is rated at 2.0 W at a potential difference of 8.0 V.
Question 1
Calculate the resistance of a lamp at this potential difference.

ohm

(2 marks)

Resistor R is selected so that the two lamps are working with their normal potential difference of 8.0 V.
Question 2
Calculate the resistance of resistor R.

ohm

(2 marks)

Questions 3 and 4 refer to the following information.
Figure 2 shows how the resistance of a light-dependent resistor (LDR) depends on the intensity of the light falling on it.

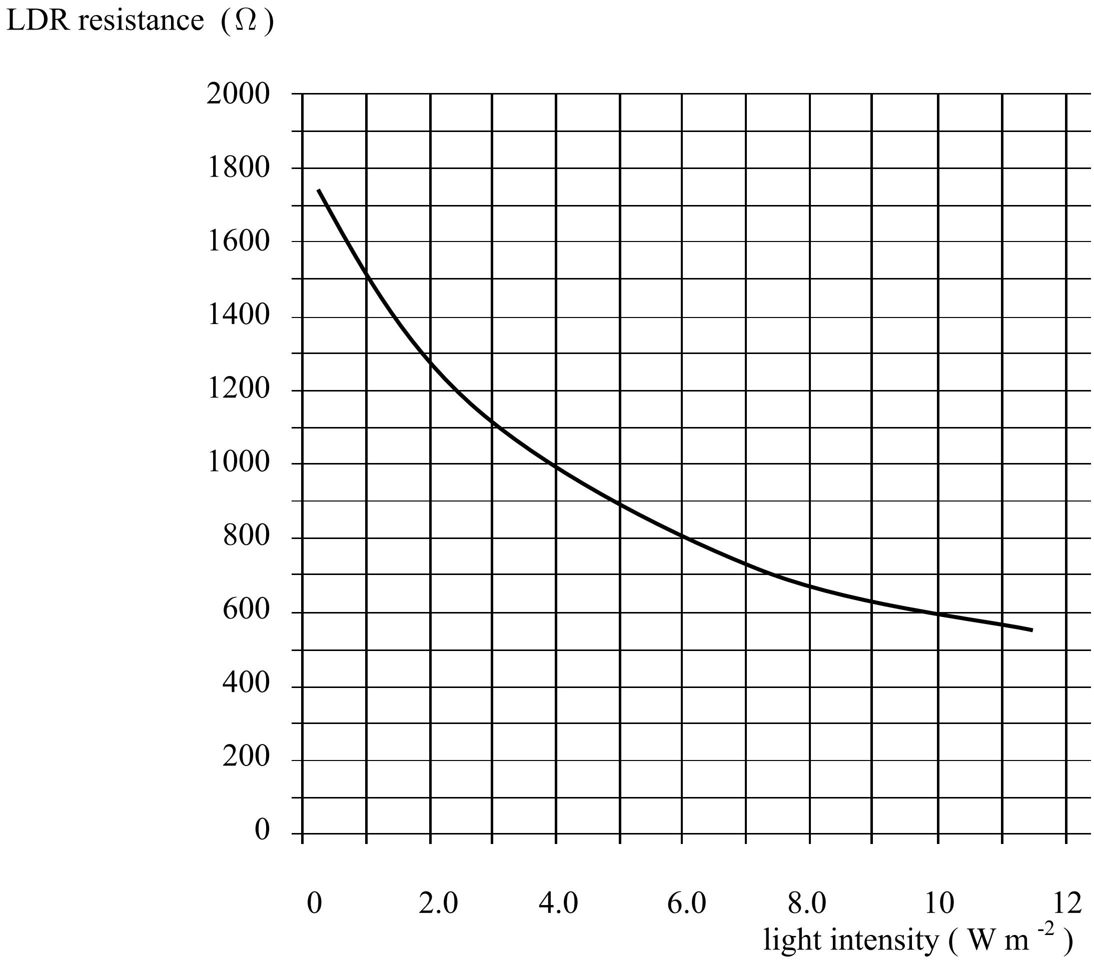


Figure 2

The LDR and a fixed resistor, R, are connected in a circuit as shown in **Figure 3.**

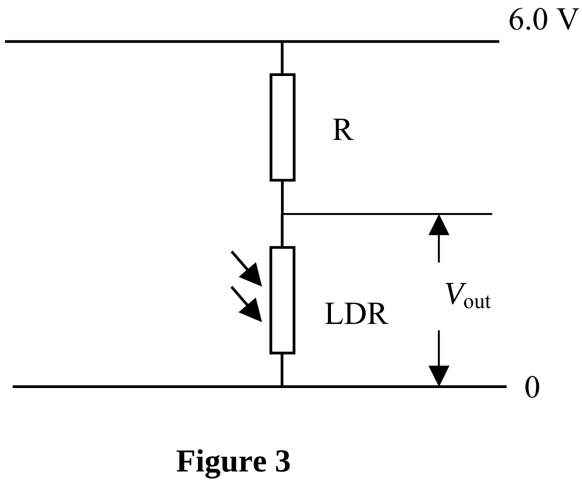


Figure 3

Question 3

Calculate the resistance, in ohm, of resistor R if the magnitude of V_{out} is to be 3.0 V when the light intensity is 1.0 W m $^{-2}$.

ohm

(2 marks)

Question 4

Calculate the light intensity for V_{out} = 2.1 V.

W m $^{-2}$

(3 marks)

Questions 5 and 6 refer to the following information.
Figure 4 shows the current – potential difference characteristics for a red light-emitting diode, LED.

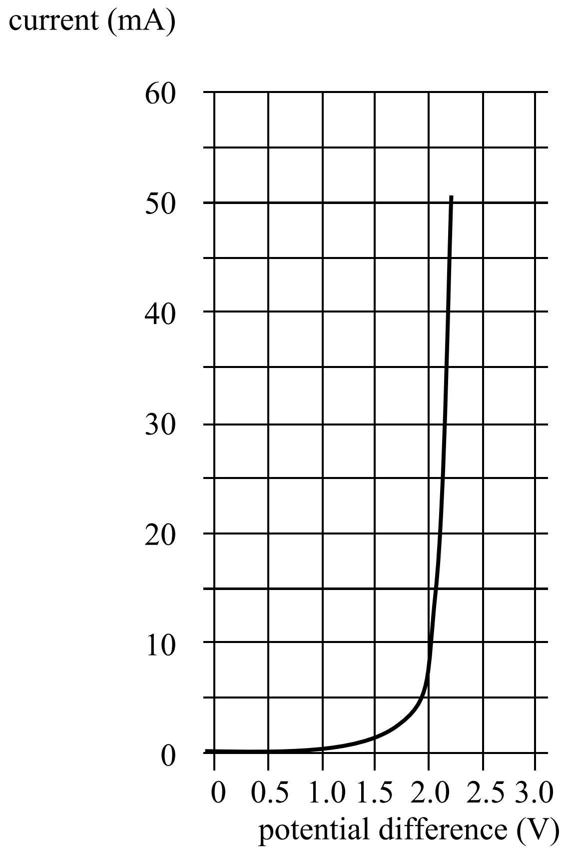


Figure 4

Question 5
Calculate the power, in mW, supplied to the LED when it is operating at a current of 50 mA.

mW

(2 marks)

LEDs are used in groups of 105 in most modern sets of traffic lights. **Figure 5** shows a portion of a single traffic light construction, showing some of the red LEDs used for the stop light. All the LEDs are connected in parallel. **Figure 6** shows a portion of the parallel circuit containing the LEDs.

portion of the total group of

LEDs.

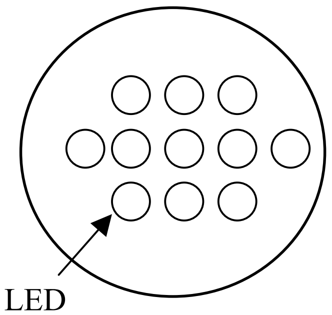


Figure 5

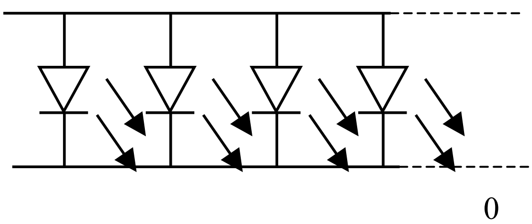


Figure 6

Each one of the 105 LEDs is operating at 50 mA.

Question 6

Calculate the total power, in W, used by the array of 105 LEDs when operating.

W

(2 marks)

Figure 7 shows a circuit with a 6.0 V emf source and a PTC thermistor in series with a 470 Ω resistor. A PTC thermistor is an electrical circuit component that increases in resistance as its temperature increases, as shown in **Figure 8**. A voltmeter measures the potential difference across the 470 Ω resistor.

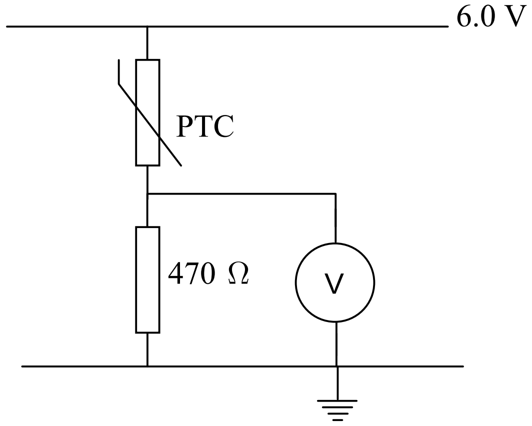


Figure 7

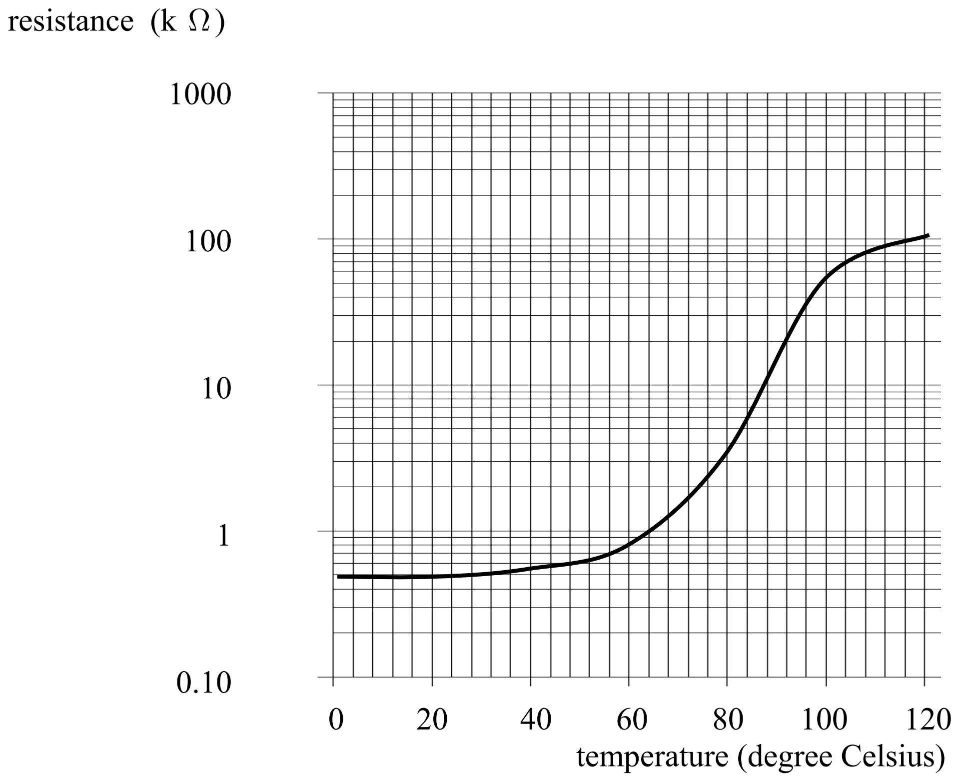


Figure 8

Question 7
What is the p.d. across the 470 Ω resistor when the temperature is 20°C?

V

(3 marks)

Questions 8 and 9 refer to the following information.
A voltage amplifier is used to amplify the AC signal input voltage from a microphone. The amplifier characteristics are shown in **Figure 9.**

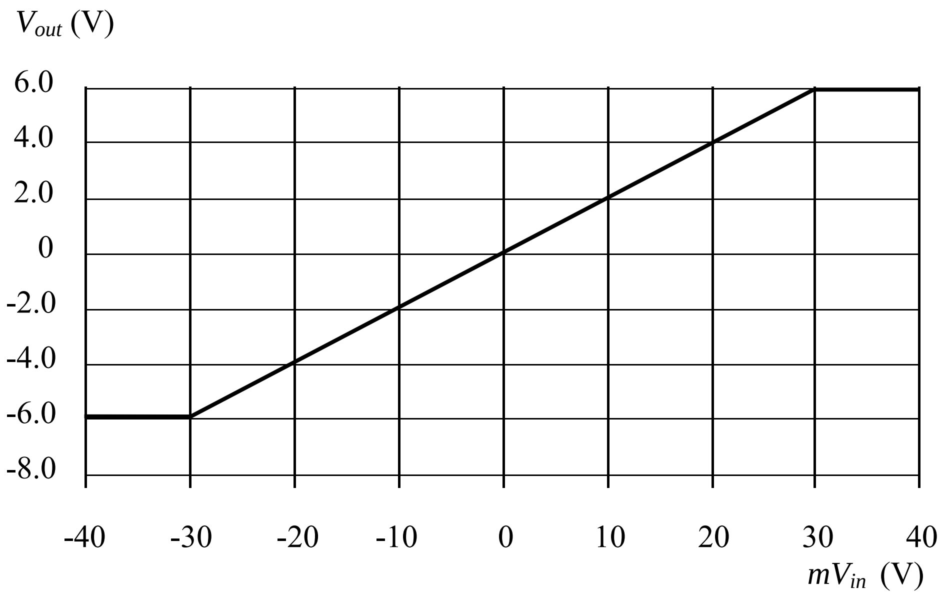


Figure 9

Question 8
Calculate the voltage gain for a signal fed into this amplifier.

gain =

(2 marks)

Figure 10 shows a sinusoidal input signal from the microphone that is fed into the amplifier.

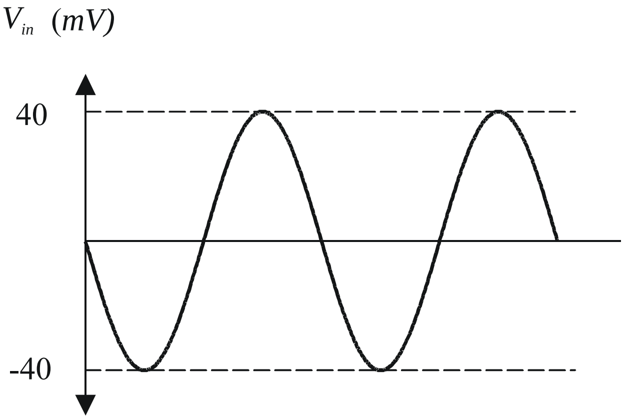
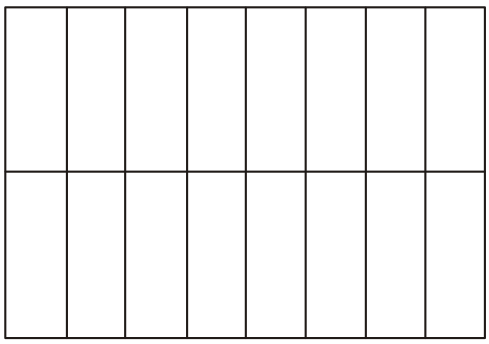


Figure 10



Question 9
On the grid below **Figure 10**, sketch the likely output signal from the amplifier, showing labelled axes and data values for voltage. Describe the effect of the amplifier on the output signal.

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(4 marks)

Demodulation is the process whereby a transmitted, modulated signal, is converted back to the original signal. **Figure 11** shows the modulated carrier signal fed into the demodulation system.

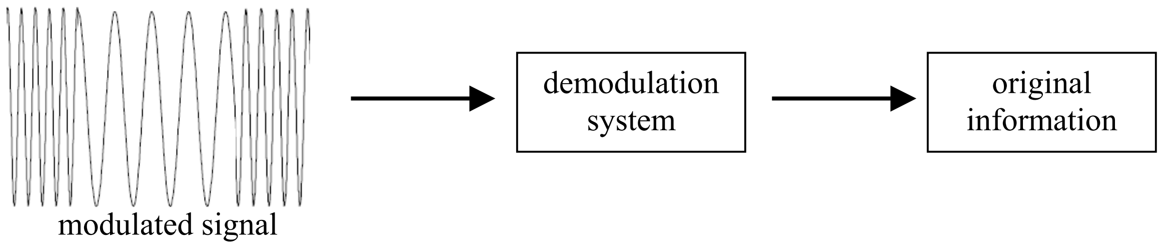


Figure 11

Figure 12 shows waveforms, A, B, C and D, that represent various signals.

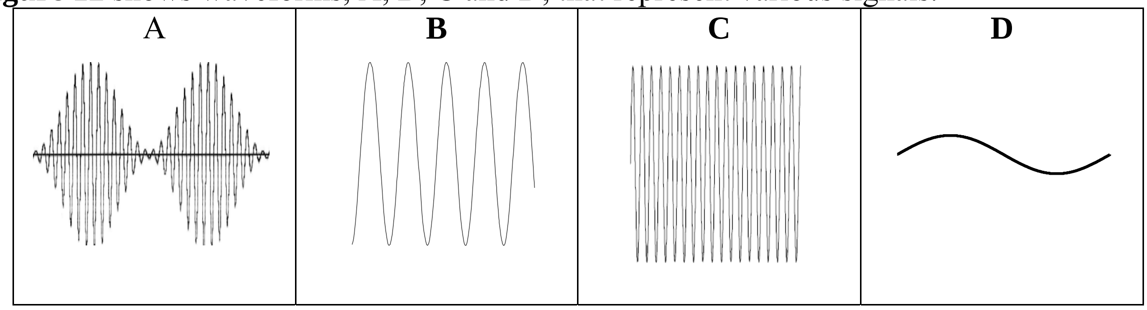


Figure 12

Question 10
In the table below write which of A, B, C and D best gives the shape of the carrier signal and the information signal that would produce the modulated signal in **Figure 12.**

information signal	
carrier signal	

(2 marks)

End of Section A

VCE Physics 2010 Year 12 Trial Exam Unit 3

Detailed Studies – Section B

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}.

Detailed Study

Detailed Study 3.3 – Materials and their use in Structures

Question 1

Which one of the following means that copper has a tensile strength of 2.5×10^{8} N m^{-2}?

A. A sample of copper will probably break if subjected to a stress of 2.5×10^{8} N m^{-2}.

B. A sample of copper will become permanently deformed if subjected to a stress greater than 2.5×10^{8} N m^{-2}.

C. Copper is not as strong as Hooke's Law.

D. A sample of copper will break if subjected to a force of 2.5×10^{8} N.

Question 2

Copper has a Young's modulus of 1.2×10^{11} N m^{-2}. A copper wire of cross sectional area 3.1×10^{-6} m^{2} is subjected to a force of 200 N.
The stress of the copper wire is

A. 1.6×10^{-8} m^{2} N^{-1}

B. 6.2×10^{-4} N m^{2}

C. 6.5×10^{7} N m^{-2}

D. 6.0×10^{8} N m^{-2}

Questions 3 and 4 refer to the following information.
Mitchell tests three elastomers (urethane, isoprene and neoprene) and plots their stress versus strain characteristics on the same set of axes. His results are shown in **Figure 1**.

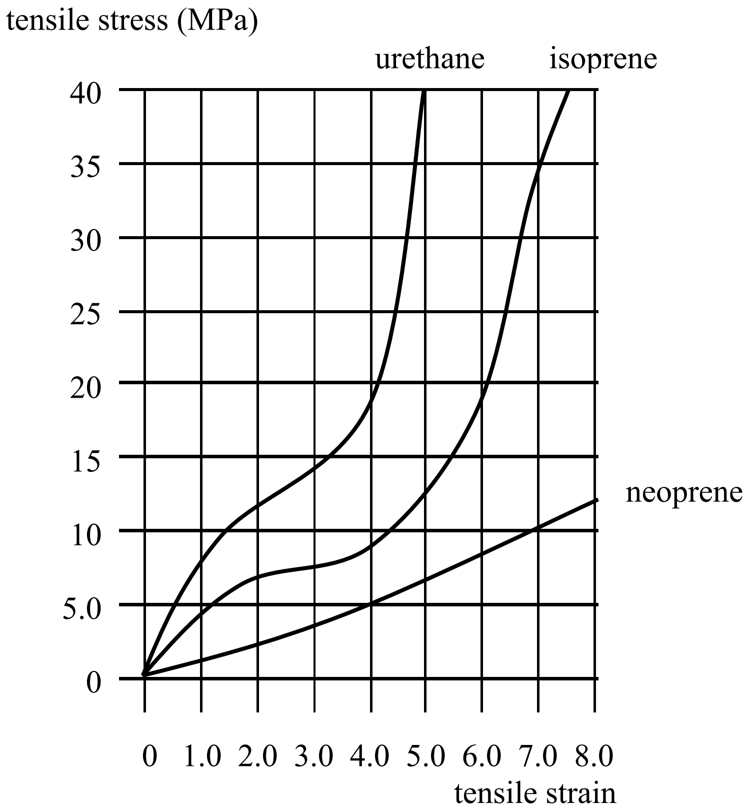


Figure 1

Question 3
The elastomer exhibiting the greatest toughness is
A. urethane.
B. neoprene.
C. isoprene.
D. impossible to tell as maximum tensile strength is not known.

Neoprene is stretched to 7 times its original length.
Question 4
The stress that the neoprene is under is
A. 10 MPa
B. 7.0 MPa
C. $1.4\times10^{6}\ \mathrm{N\,m^{-2}}$
D. $3.5\times10^{7}\ \mathrm{J\,m^{-3}}$

Questions 5 to 8 refer to the following information.
The stress–strain characteristics of a material are shown in **Figure 2**.

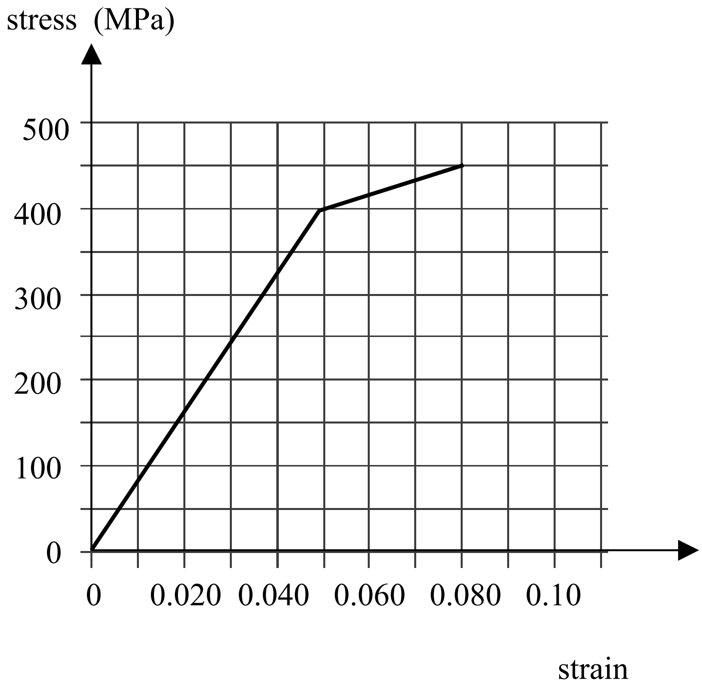


Figure 2

Question 5
The elastic limit of this material is
A. 450 MPa.
B. 400 MPa.
C. 8.0×10^3 Pa.
D. 5.6×10^9 Pa.

Question 6
The strain energy per unit volume required to fracture this material is
A. $2.3\times10^7\ \mathrm{J\,m^{-3}}$
B. $8.0\times10^8\ \mathrm{J\,m^{-3}}$
C. $1.0\times10^7\ \mathrm{J\,m^{-3}}$
D. $1.8\times10^7\ \mathrm{J\,m^{-3}}$

Questions 7 and 8 refer to the following information:
Ly tests the behaviour of a 0.50 m long piece of metal wire, measuring the extension of the wire as a function of the tensile force applied to it. The wire has a cross-sectional area of 1.0×10^{-6} m^2. She produces the following force versus extension graph shown in **Figure 3**.

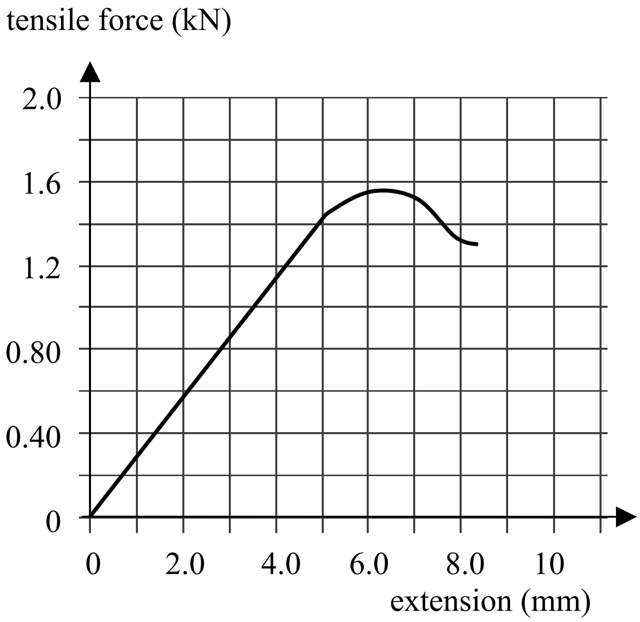


Figure 3

Question 7
The strain of the wire when the tensile force is 1.4 kN is
A. 5.0 mm
B. 2.8×10^{8} N m^{-2}
C. 0.010
D. 0.005 mm

Question 8
The best estimate of the elastic strain energy stored in the wire for a load force of 1.4 kN is
A. 0.010 J.
B. 3.5 J.
C. 0.28 J.
D. 0.56 J.

Figure 4 shows a car park barrier of uniform length 4.0 m, and weight, *W*, balanced in a horizontal position by a 500 N counterweight placed a distance of 0.60 m from the pivot.

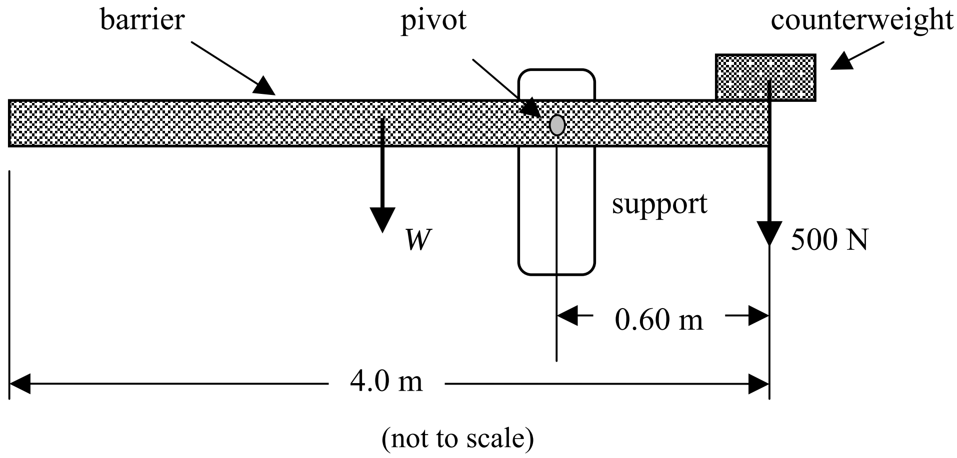


Figure 4

Question 9
The mass, in kg, of the barrier is
A. 214
B. 21
C. 15
D. 88

Figure 5 shows a screwdriver being used to prise open a tin of paint. The end of the screwdriver is placed under the lip of the lid and the handle is pushed down. The resistance force of the lid is 400 N.

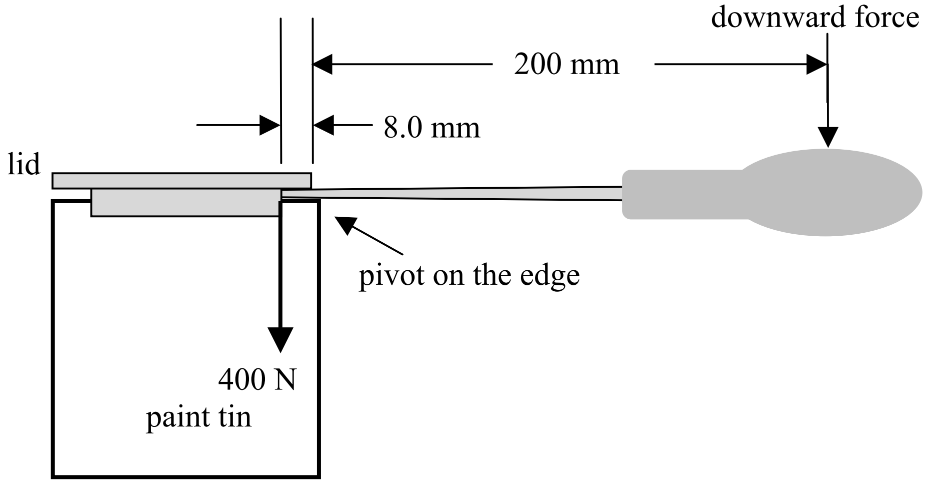


Figure 5

Question 10
The minimum downward force required to just lever off the lid is
A. 16 N.
B. 400 N.
C. 21 N.
D. 416 N.

Questions 11 and 12 refer to the following information.
A long, thin piece of uniform metal wire hangs vertically and weights are attached to its lower end.
Starting from zero, weights are gradually increased to a certain value and then decreased again to zero. Values for tensile stress are plotted against tensile strain for this exercise, as shown in **Figure 6.**

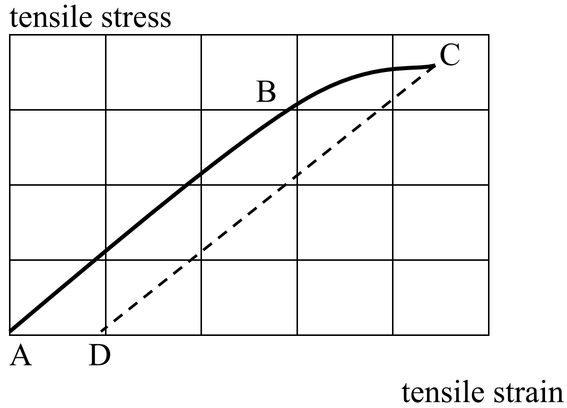


Figure 6

Question 11
Figure 6 shows that the material of the wire is
A. brittle.
B. ductile.
C. hard.
D. malleable.

Question 12
The permanent strain of the wire is shown by the point on the graph labelled
A. A.
B. B.
C. C.
D. D.

Question 13
The best explanation for plastic behaviour of materials is

A. that the material returns to its original dimensions when the force is removed. The particles in the material return to their original positions.
B. that the material does not return to its original dimensions when the force is removed. The particles in the material return to their original positions.
C. that the material returns to its original dimensions when the force is removed. The particles in the material do not return to their original positions.
D. that the material does not return to its original dimensions when the force is removed. The particles in the material do not return to their original positions.

End of Section B

End of Trial Exam

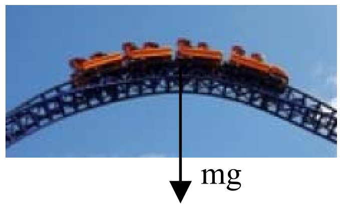
Suggested Answers

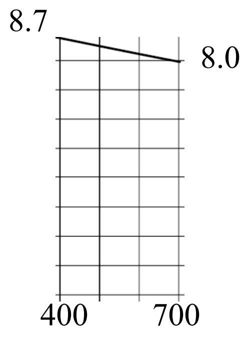
VCE Physics 2010 Year 12 Trial Exam Unit 3

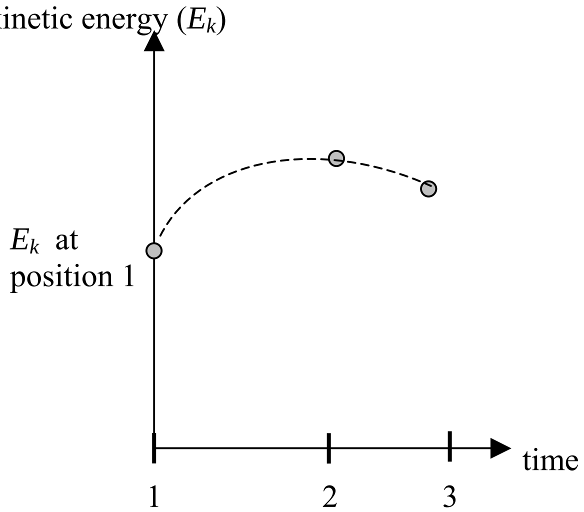
Core – Section A

Question	Area of Study 1 – Motion in One and Two Dimensions	Mark allocation
1	The person will experience the effect of the horizontal acceleration, but this will not effect the weight of the person. Use; $W = mg$ $= 70\times10$ $= 7.0\times10^2$ N	 1 1
2	The weight of the person is; $W = mg$ $= 80\times10$ $= 800$ N The net force acting on the person at this instant is; $800 - 200 = 600$ N downward. Use; $a = \frac{F}{m}$ $= \frac{600}{80}$ $= 7.5\,\mathrm{m\,s^{-2}}$	 1 1
3	The value of the spring constant, k, is given by the gradient of the $F - x$ graph. $k = \frac{80}{1.0}$ $= 80\ \mathrm{N\,m^{-1}}$	2
4	The system is moving with a constant acceleration, a; $a = \frac{F}{m}$ $= \frac{6.0}{4.0+6.0}$ $= 0.60\ \mathrm{m\,s^{-2}}$ The force exerted on the 4.0 kg block by the spring is; $F_{spring} = 4.0\times0.60$ $= 2.4$ N	 1 1

5	Use; $F_{spring} = kx$ $x = \frac{F}{k}$ $= \frac{2.4}{80}$ $= 0.030 \text{ m}$	1 1
6	The strain potential energy is numerically equal to the area under the force-distance graph. Use; $E_S = \frac{1}{2}kx^2$ $= \frac{1}{2} \times 80 \times 0.030^2$ $= 3.6 \times 10^{-2} \text{ J}$	1 1
7	It is required to find the vertical height of the ball at a distance of 130 m from where it was struck. horizontal speed component $= u_X \cos 25^0$ $= 45 \cos 25^0$ $= 40.8 \text{ m s}^{-1}$ vertical speed component $= u_Y \sin 25^0$ $= 45 \sin 25^0$ $= 19.0 \text{ m s}^{-1}$ The time to reach a distance of 130 m; $x = u_X \cos 25^0 \times t$ $t = \frac{130}{u_X \cos 25^0}$ $= 3.19 \text{ s}$ Let y be the vertical height at time t ; $y = u_Y\ t - \frac{1}{2}gt^2$ $= (19 \times 3.19) - \frac{1}{2}(10 \times 3.19^2)$ $= 9.73 \text{ m}$ The height above ground level of the ball is 9.7 m, so the ball clears the fence by 6.7 m. The batter has hit a home run.	 1 1 1 1

8	Let F be the friction force. Force along the slope = acceleration along the slope. $F + mg\sin\theta = \frac{mv^2}{r}\cos\theta$ for F = 0, and re-arranging $\text{Tan}\,\theta = \frac{v^2}{gr}$ $= \frac{25\times 25}{10\times 200}$ $= 17^0$	1 1
9	To experience weightlessness at the top of the hill, the normal reaction of the track on the roller coaster must equal zero. From; $mg - N = \Sigma F$ when $N = 0$, $mg = \frac{mv^2}{r}$ $v = \sqrt{gr}$ $= \sqrt{10\times 20}$ $= 14\,\text{m}\,\text{s}^{-1}$  	1 1
10	Z gives the direction of the acceleration.	2
11	Use; $a_c = \frac{v^2}{r}$ $1.6 = \left\{\frac{2\pi r}{T}\right\}^2 \times \frac{1}{r}$ $T = \sqrt{\frac{4\pi^2 r}{a}}$ $= \sqrt{\frac{4\times\pi^2\times 75}{1.6}}$ $= 43$	1 1

<table>
<tr><td>12</td><td>Work done against gravity to deploy the satellite to a greater altitude, is numerically equal to the area under the field strength-distance graph multiplied by the mass of the satellite.


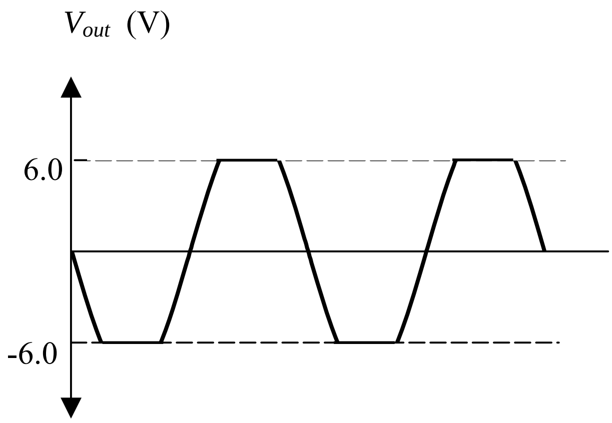
The area of the trapezium is;
$(\frac{8.7+8.0}{2})\times 300\times 10^{3}\times 900$
$=2.3\times 10^{9}\mathrm{J}$</td><td>2</td></tr>
<tr><td>13</td><td>As the meteor travels from position 1 to position 3, the kinetic energy increases to a maximum at position 2 then decreases to a lower value at position 3, but greater than at position 1.


As the meteor gets closer to the moon, gravitational potential energy decreases and kinetic energy increases. In order of increasing kinetic energy; $P_2 > P_3 > P_1$</td><td>1
1
1</td></tr>
<tr><td>14</td><td>Use;
$g=\frac{GM}{R^{2}}$
when g is graphed against $\frac{1}{R^{2}}$, the gradient of the graph $=GM$.
gradient $=\frac{6.0}{1.5\times 10^{-14}}$
$M=\frac{4.0\times 10^{14}}{6.67\times 10^{-11}}$
$M=6.0\times 10^{24}$ kg</td><td>1
1</td></tr>
</table>

15	Gravitational potential energy is converted to kinetic energy on moving down the slope. loss in E_P = gain in E_K $mgh = \frac{1}{2}mv^2$ $h = \frac{3.5^2}{2 \times 10}$ =0.613 m =0.61 m	1 1
16	Use; $p = mv$ $\Sigma p_i = \Sigma p_f$ $2.0 \times 3.5 = (2.0 \times v) + (3.0 \times 2.0)$ $7.0 = 2.0v + 6.0$ $v = 0.50 \text{ m s}^{-1}$	1 1
17	Work done by the friction force = loss in kinetic energy $F \times x = \frac{1}{2}mv^2$ $F = \frac{3.0 \times 2.0 \times 2.0}{2 \times 0.5}$ $= 12 \text{ N}$	1 1
18	For the collision to be elastic; Σ Initial E_k must equal Σ final E_k $\Sigma E_{K\,initial} = \frac{1}{2} \times 2.0 \times 3.5^2$ $= 12.3 \text{ J}$ $\Sigma E_{K\,final} = (\frac{1}{2} \times 2.0 \times 0.50^2) + (\frac{1}{2} \times 3.0 \times 2.0^2)$ $= 0.25 + 6.0$ $= 6.25 \text{ J}$ $\Sigma E_{K\,initial} \neq \Sigma E_{K\,final}$ The collision is in elastic.	1 1 1

Question	Area of Study 2 – Electronics and Photonics	Mark allocation
1	For one lamp; Use $P=\dfrac{V^2}{R}$ $R=\dfrac{8^2}{2.0}$ $=32\ \Omega$	1 1
2	First calculate the circuit current. For each lamp; $P=VI$ $I=\dfrac{2.0}{8.0}$ $=0.25\ \text{A}$ The total circuit current is then 2 x 0.25 = 0.50 A For resistor R; $R=\dfrac{V}{I}$ $=\dfrac{12-8.0}{0.50}$ $=8.0\ \Omega$	1 1
3	For light intensity of 1 W m $^{-2}$, the resistance of the LDR as read from the graph is 1500 Ω. Since the p.d. across each component is the same (3.0 V), the resistance of the resistor R is 1500 Ω.	1 1
4	Use; $R=1500\ \Omega$ $\Delta V_{LDR}=2.1$ $\Rightarrow \Delta V_R=6.0-2.1$ $=3.9\ \text{V}$ $I=\dfrac{3.9}{1500}=2.6\times10^{-3}\,\text{A}$ $R_{LDR}=\dfrac{V}{I}$ $=\dfrac{2.1}{2.6\times10^{-3}}$ $=808$ $=8.1\times10^{2}\ \Omega$ From **Figure 3**, this resistance corresponds to a light intensity of 6.0 W m $^{-2}$.	1 1 1

5	When the current is 50 mA, the p.d. is 2.2 V (from the graph). $P_{LED} = VI$ $= 2.2 \times 50$ mW $=110$ mW	1 1
6	Each LED is supplied with 110 mW of power. For 105 LEDs; Total power supplied is; $110 \times 105 = 11550$ mW $= 11.6$ W $= 12$ W	1 1
7	At 200 C, the resistance of the PTC is 0.50 k Ω. The total resistance of the circuit is; $470 + 500$ $= 970\ \Omega$ The current in the circuit is; $I = \frac{V}{R}$ $= \frac{6.0}{970}$ $= 0.00619$ A The p.d. across the $470\,\Omega$ resistor is; $V = IR$ $= 0.00619 \times 470$ $= 2.9$ V	1 1 1
8	The voltage gain for the amplifier is given by the gradient of the sloping section of the graph. Gradient is; $= \frac{6.0-(-6.0)}{\{(30-(-30)\} \times 10^{-3}}$ $= \frac{12}{60 \times 10^{-3}}$ $= 200$	2

<table>
<tr><td>9</td><td>

The amplifier is non-inverting and the output signal is similar in waveform to the input signal, but input signal voltages greater or less than ± 30 mV will be clipped.</td><td>2

2</td></tr>
<tr><td>10</td><td>The signal shown is frequency modulated.
The carrier signal has a higher frequency than the information signal.
<table><tr><td>information signal</td><td>B</td></tr><tr><td>carrier signal</td><td>C</td></tr></table></td><td>1

1</td></tr>
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Detailed Studies – Section B

Question	Detailed Study – Materials and their use in Structures	
1	**B**	A sample of copper will become permanently deformed if subjected to a stress greater than 2.5×10^8 N m^{-2}.
2	**C**	$\sigma = \dfrac{F}{A}$ $= \dfrac{200}{3.1 \times 10^{-6}}$ $= 6.5 \times 10^7$ N m^{-2}
3	**C**	The area under the graph is a measure of toughness. The area under the isoprene curve is the greatest.
4	**A**	When the neoprene is stretched to seven times its original length, the stress is 10 MPa.
5	**B**	400 MPa or 4.0×10^8 N m^{-2} (end of elastic region)
6	**A**	Estimate the area under the characteristic. $= (\frac{1}{2} \times 0.050 \times 400 \times 10^6) + (425 \times 10^6 \times 0.030)$ $= 2.3 \times 10^7$ J
7	**C**	$strain\,(\varepsilon) = \dfrac{\Delta L}{L}$ $= \dfrac{5.0 \times 10^{-3}}{0.50}$ $= 0.010$
8	**B**	Elastic strain energy is the area under the force versus extension graph. $\text{area} = \frac{1}{2} \times (5.0 \times 10^{-3}) \times 1.4 \times 10^3$ $= 3.5$ J

9	**B**	The beam is balanced in the horizontal position. Take torques about the pivot. $\Sigma\tau_{CW} = 500 \times 0.60$ $= 300$ The weight of the beam acts at the centre of the beam and is 2.0 m from the end. The weight force is acting at a distance of (2.0 - 0.60) m from the pivot. $\Sigma\tau_{ACW} = W \times 1.4$ $\Sigma\tau_{CW} = \Sigma\tau_{ACW}$ $300 = W \times 1.4$ $W = 214\text{ N}$ so, the mass is $\frac{214}{10} = 21.4$ $= 21\text{ kg}$
10	**A**	Take torques about the edge of the tin at the pivot point. Let F be the required force. $\Sigma\tau_{CW} = 0.20 \times F$ $\Sigma\tau_{ACW} = 400 \times 0.0080$ $\Sigma\tau_{CW} = \Sigma\tau_{ACW}$ $F = \frac{400 \times 0.0080}{0.20}$ $= 16\text{ N}$
11	**B**	The characteristic of the material of the wire indicates that it is ductile.
12	**D**	The permanent strain of the wire is indicated by the point D on the graph.
13	**D**	Plastic behaviour of a material occurs when the material does not return to its original dimensions after the deforming force is removed. The particles in the material do not return to their original positions.

End of Suggested Answers