Lisachem Materials

Chemistry Physics Biology Psychology

VCE PHYSICS 2007
TRIAL EXAM 1 UNIT 3

Reading Time: 15 minutes
Writing Time: 90 minutes

Structure of Booklet

Section	No of Questions	No of Questions to be answered	No of Marks
A Core Areas of Study			
1. Motion in one and two dimensions	18	18	40
2. Electronics and photonics	12	12	25
B Detailed Study			
3. Investigating materials and their use in structures	10	10	25

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, up tp two pages (one A4 sheet) of pre-written notes (typed or handwritten) and an approved graphics calculator (memory cleared) and/or one 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 answer booklet with detachable formula sheet.

Instructions
Detach the formula sheet from the book during reading time.
Write your name in the space provided..
Answer all questions in this questions and answer book where indicated.
Always show your working 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.

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Student name……………………………………

Formula Sheet

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	$V_{RMS} = \frac{1}{2\sqrt{2}}V_{p-p} \qquad I_{RMS} = \frac{1}{2\sqrt{2}}I_{p-p}$
15	voltage;power	$V = RI \qquad P = VI$
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	$G = 6.67 \times 10^{-11}\ \text{N m}^2\ kg^{-2}$
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 = 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

VCE Physics 2007 Year 12 Trial Exam Unit 3

SECTION A–Core

Instructions for Section A
Answer all questions for both Areas of Study in this section of the paper.

Area of Study 1–Motion in one and two dimensions

Figure 1 shows Joe traveling on an up escalator that is moving with a speed of 1.5 m s^{-1} . Mary is on a parallel escalator that is moving down with a speed of 1.5 m s^{-1}.

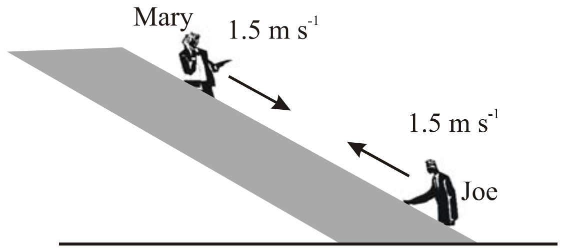


Figure 1

Question 1
Calculate the speed of Mary relative to Joe.

m s^{-1}

2 marks

When standing on the moving escalator Joe is carried to the top in a time of 60 s. The next day, the escalator has stalled. Joe walks up the stalled escalator and reaches the top in a time of 90 s.

Question 2
Calculate the time it would take Joe to walk up the moving escalator to the top.

s

3 marks

Eric stands motionless on a set of bathroom scales and notes the reading as 300 N. He then crouches down and suddenly jumps up. Jason, who is watching, notes that the reading on the bathroom scales momentarily increases to 400 N when Eric jumps up.

Question 3
Calculate the magnitude of Eric's maximum acceleration as he jumps up.

m s^{-2}

3 marks

Ashleigh drove her car of mass 900 kg along a straight horizontal road with a speed of 20 m s $^{-1}$. She applied the brakes and slowed down to a speed of 5.0 m s $^{-1}$ in 10 s.
Ignore effects due to friction.

Figure 2

Question 4
Calculate the magnitude of the braking force that acted on the car.

N

2 marks

Figure 3 shows a mass of 0.10 kg that is attached to a hanging mass of 0.90 kg by a cord. The table is frictionless and the small mass rotates in a circular path.

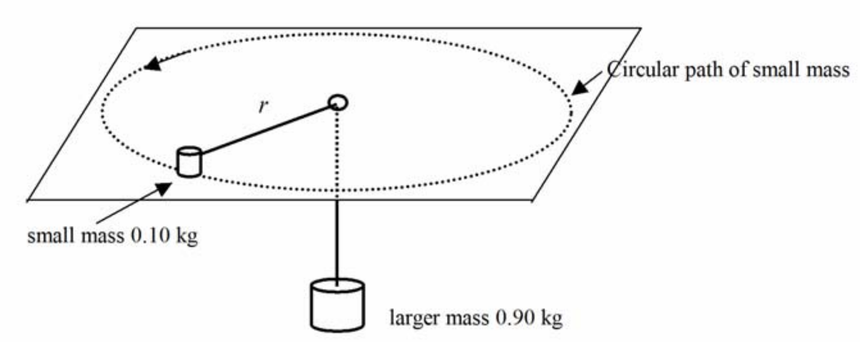


Figure 3

Question 5
Calculate the speed of rotation, in m s $^{-1}$, of the 0.10 kg mass which will keep the 0.90 kg mass at rest, if the radius of rotation, r, is 0.80 m.

m s $^{-1}$

2 marks

Questions 6 - 7 refer to the following information.
During a game of rugby, a football is kicked off with an initial speed of 18 m s $^{-1}$ at an angle of 45^0 to the horizontal playing field. A receiver on the goal line 50 m away in the direction of the kick begins running to meet the ball at the instant it is kicked as shown in Figure 4.

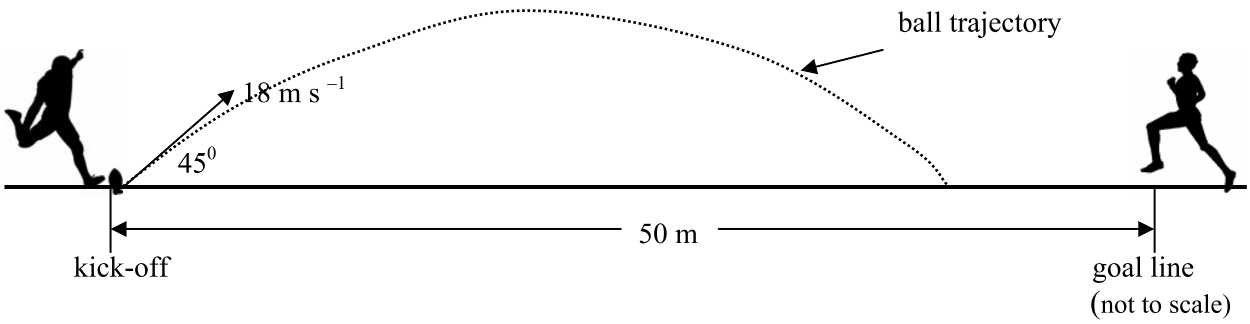


Figure 4

Question 6
Calculate the time the ball is in the air before being caught by the receiver.

s

2 marks

Question 7
Calculate the average speed of the receiver if he is to catch the ball before it hits the ground.

m s $^{-1}$

3 marks

Questions 8 - 9 refer to the following information.

An elevator filled with passengers has a total mass of 2500 kg as shown in Figure 5 . The cable snaps when the elevator is at rest at the first floor of a building. At this instant the bottom of the elevator is 3.0 m above the top of a cushioning spring. The spring is compressed by 0.50 m in bringing the elevator to rest initially.

Ignore the mass of the spring in this question.

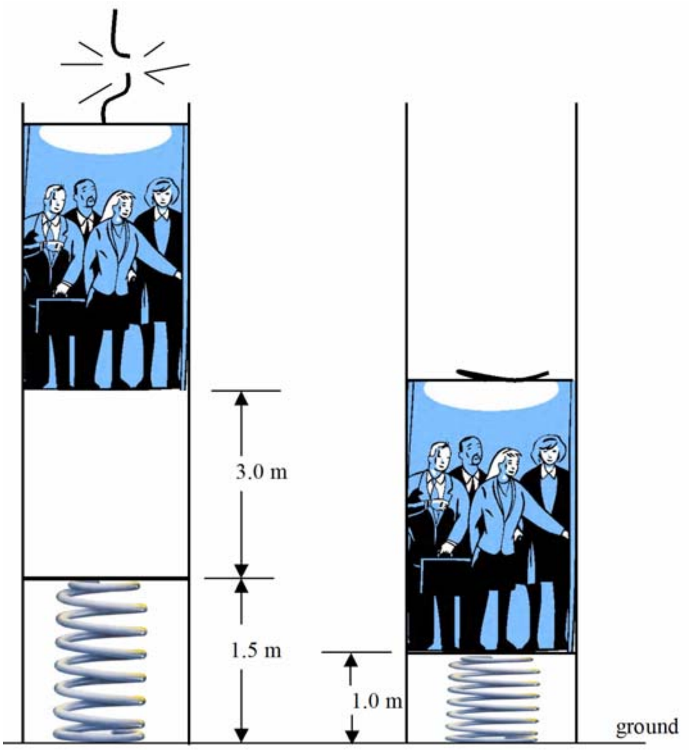


Figure 5

Question 8

Calculate the speed of the elevator as it first makes contact.

m s $^{-1}$

2 marks

Question 9

Calculate the spring constant of the spring.

N m $^{-1}$

3 marks

Questions 10 - 12 refer to the following information.
Figure 6 shows a train with an engine, a coal truck and carriage travelling at constant velocity along a straight, horizontal section of track. The mass of the engine is 20.0 tonnes and the mass of each of the carriages is 10.0 tonnes.
At this constant velocity the resistance force (due to frictional forces and air resistance) on the engine is 2000 N and the carriage and coal truck experience a resistance force of 1500 N.

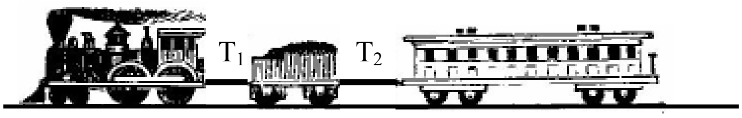


Figure 6

Question 10
Calculate the magnitude of the driving force provided by the engine.

N

2 marks

While still on the same section of track, the train is required to speed up and so the engine driving force is increased to 2.5×10^4 N.

Question 11
Calculate the acceleration of the train during this process. Assume that the resistance forces have not changed.

$m\ s^{-2}$

2 marks

During another part of the journey the train is accelerating at 0.20 $m\ s^{-2}$ along a straight, level section of track.

Question 12
Calculate the magnitude of the tension (T_1) in the coupling between the engine and the coal truck during this acceleration. (Assume that the resistance forces remain the same as before).

N

3 marks

Questions 13 - 14 refer to the following information.

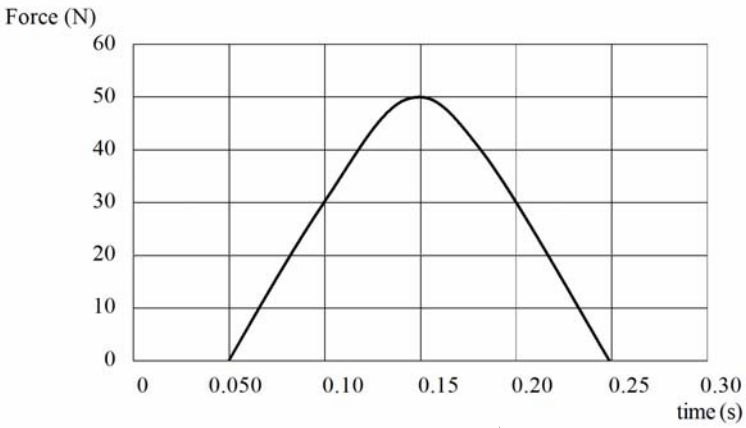


Figure 7

Anne throws a volleyball of mass 0.20 kg vertically into the air to serve. She strikes the ball with her hand at the instant the ball is motionless in the air. The force exerted by her hand on the ball varies with time as shown in Figure 7.

Question 13

Estimate the impulse of the force exerted by Anne's hand on the ball.

N s

2 marks

Question 14

Calculate the speed of the ball immediately after impact with Anne's hand.

$m\ s^{-1}$

2 marks

Questions 15 - 18 refer to the following information.

One of the more than 200 extra-solar planets discovered recently revolves in a circular path around a star, (HR 7291, found in the constellation Sagittarius), at a distance of 7.7×10^{9} m (between centres). The period of the planet is 3.09 days.

Question 15

Calculate the orbital velocity, in $m\ s^{-1}$, of the planet.

$m\ s^{-1}$

2 marks

Question 16
Calculate the mass, in kg, of the parent star.

kg

2 marks

The mass of the planet revolving around star HR 7291 is 1.6×10^{26} kg.

Question 17
Calculate the magnitude of the gravitational force of attraction between the planet and star HR 7291.

N

2 marks

Question 18
How would the surface temperature of this planet compare with that of the Earth's surface temperature?

………..
1 mark

END OF AREA OF STUDY 1
Continue.

Area of Study 2–Electronics and photonics

Questions 1 – 2 refer to the following information.

In Figure 1, five resistors are used to construct a circuit that could be used as a voltage divider. The voltage source across this circuit is 60 V_{RMS}.

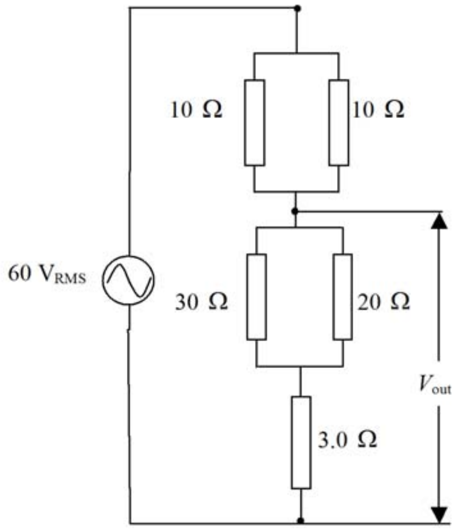


Figure 1

Question 1

Calculate the RMS output voltage, V_{out}.

	V

3 marks

Question 2

Calculate the electrical energy dissipated in the 3.0 Ω resistor in Figure 1 in one second.

	J

2 marks

Questions 3 – 7 refer to the following information.
A light-emitting diode (LED) is a special type of diode that emits light when the current through it exceeds about 20 mA. Figure 2 shows the current-voltage characteristics for a particular LED.
The circuit shown in Figure 3 consists of an LED connected in series with a 250 Ω resistor. The current in the circuit is 60 mA and the LED glows brightly.

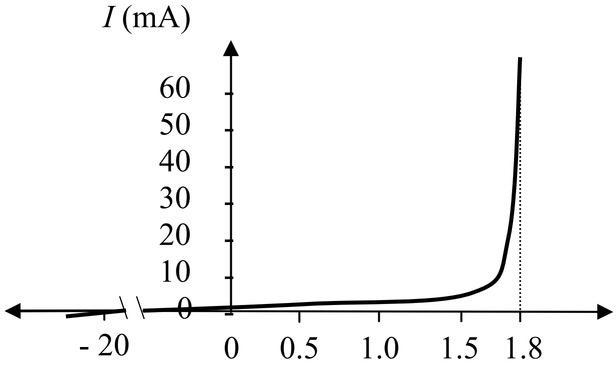


Figure 2

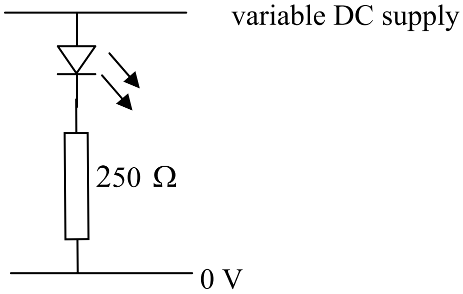


Figure 3

Question 3
Determine the voltage drop across the LED.

| V |

1 mark

Question 4
Calculate the voltage drop across the 250 Ω resistor.

| V |

2 marks

Question 5
Calculate the emf of the supply.

| V |

2 marks

The LED connection in the circuit is now reversed and the input voltage is adjuted to 20 V.

Question 6

Determine the current flowing in the circuit. Justify your answer.

___

___

2 marks

The LED is again correctly biased and the power supply is changed back to its original value. A total current of 60 mA flows in the circuit.

A 500 Ω resistor is now connected in parallel with the LED, which continues to glow brightly.

Question 7

Calculate the current, in mA, flowing through the 500 Ω resistor.

mA

2 marks

Question 8

Which one of the following sets of material gives the correct order for increasing conductivity?

A semiconductor, conductor, insulator

B insulator, semiconductor, conductor

C insulator, conductor, semiconductor

D conductor, semiconductor, insulator

2 marks

Questions 9 – 11 refer to the following information.

Figure 4 shows a typical single stage n-p-n transistor voltage amplifier circuit. The transfer characteristics of this particular transistor are shown in Figure 5.

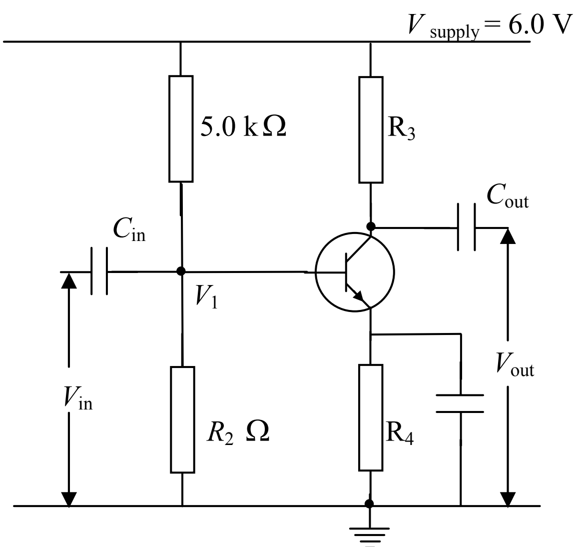


Figure 4

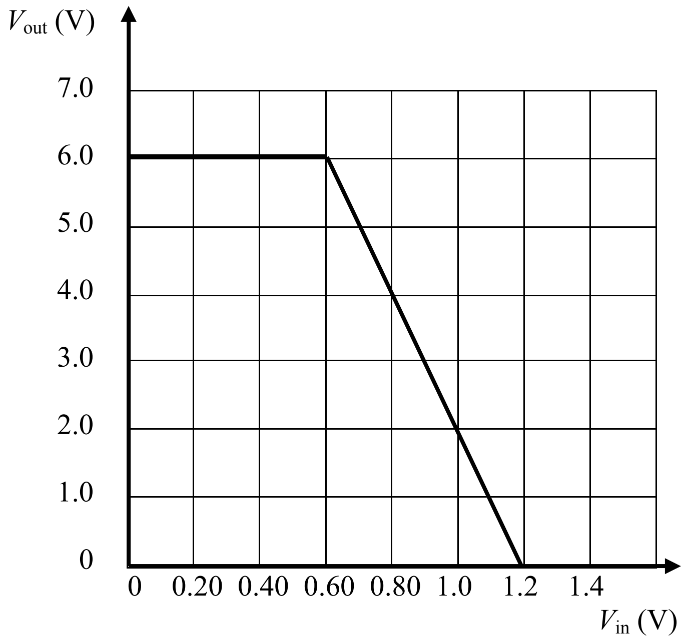


Figure 5

In this circuit, the potential at $V_1 = 0.90$ V.

Question 9

Calculate the resistance of resistor, $R_{2,}$ in kΩ

kΩ

3 marks

Question 10

Determine the magnitude of V_{out} when V_{in} is 0.50 V

V

1 mark

A small time-varying AC voltage as shown in Figure 6 is applied at the input of the circuit.

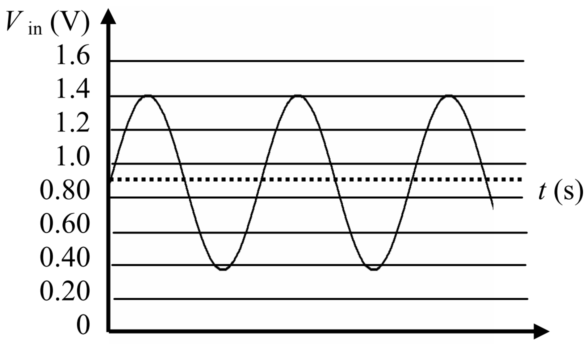


Figure 6

Question 11
Sketch on the grid below the output signal for the input signal shown in Figure 7.

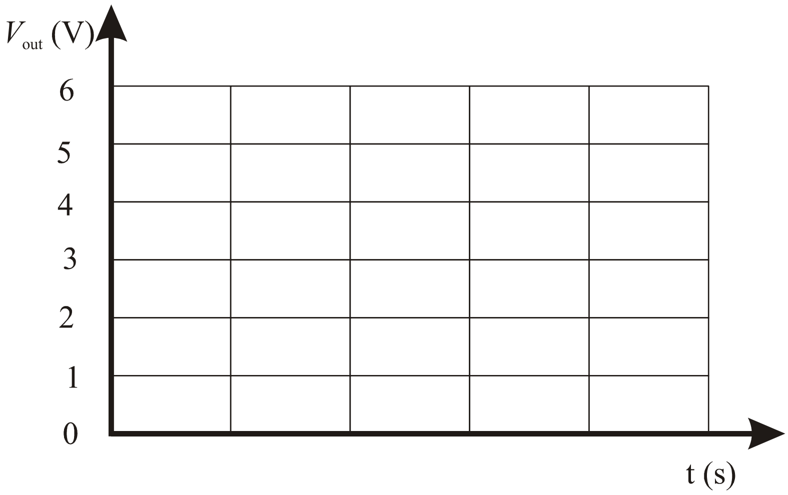


Figure 7

2 marks

The transistor in Figure 4 is operating with a current gain of 200. Resistor R_3 is 4.7 kΩ.

Question 12
If the base current is 5.0 μA, calculate the potential difference across R_3.

V

3 marks

END OF SECTION A

SECTION B – Detailed study

Instructions for Section B
Answer all the questions on this Detailed study.

Detailed study 2 – Investigating materials and their use in structures.

Questions 1 – 4 refer to the following information.

The stress-strain graphs for three materials, A, B and C are shown in Figure 1.

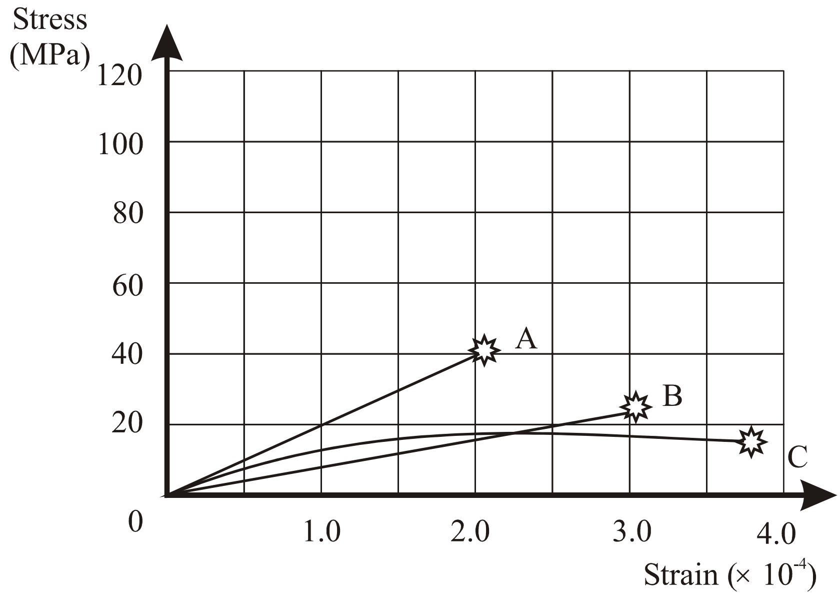


Figure 1

Question 1

Calculate Young's modulus for material A using the information from the graph.

N m $^{-2}$

2 marks

Question 2

Which one of the three materials is the stiffest? Justify your answer.

2 marks

Question 3

Which one of the three materials is the toughest? Justify your answer.

2 marks

Question 4

Calculate the strain energy per unit volume for a rod of material A subjected to a stress of 20 MPa. Show your working.

J m $^{-3}$

2 marks

A thin brass rod, of cross-sectional area $1.1 \times 10^{-6}\ \text{m}^2$, reaches its elastic limit when subjected to a stress of 380 MPa.. During a test, a mass of 50 kg is suspended from the rod.

Question 5

Determine whether or not the rod will exceed its elastic limit. Show your working and justify your answer.

3 marks

Jason is a P-plater and has got his car stuck in mud on the shoulder of a road. Fortunately, there was a utility pole close by. He firmly fixed one end of a steel cable to the front of his car and the other end to the utility pole, 10 m away so that the cable was taut. He then pulled sideways on the cable at its midpoint with a force of 500 N.

The centre of the cable is displaced a distance of 0.50 m from its initial position. The car is just on the point of moving. Figure 2 shows the situation.

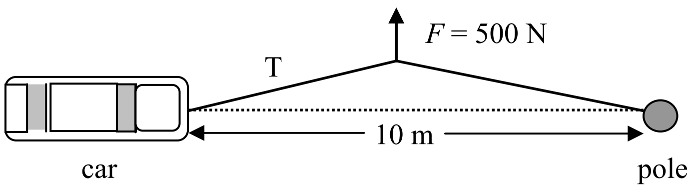


Figure 2

Question 6

Calculate the tension, T, in the cable just as the car moves.

N

3 marks

Questions 7 – 9 refer to the following information.

A uniform bearer of length 10 m beneath a floor has a mass of 600 kg and is supported by two stumps, A and B, at either end of the bearer. A large machine of mass 10 tonne is placed on the floor a distance of 2.5 m from one end of the bearer B as shown in Figure 3.

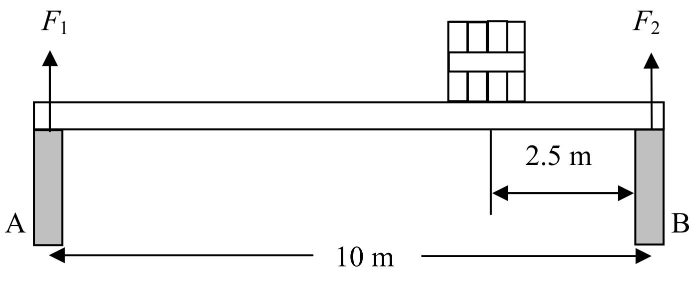


Figure 3 (not to scale)

Question 7
Calculate the magnitude of each of the forces, F_1 and F_2.

$F_1 =$	$F_2 =$

3 marks

The two stumps are made of concrete, which has a compressive strength of $2.0\times10^{7}\ \text{N m}^{-2}$. A safety factor of 6 is used.

Question 8
Calculate the required minimum cross-sectional area, in m^2, of concrete stump B.

m^2

3 marks

Question 9
Under this given load, calculate the amount of compression, in mm, of stump B if the original length is 1.0 m. Young's modulus for concrete is $2.0\times10^{10}\ \text{N m}^{-2}$.

mm

2 marks

Concrete is reasonably strong under compression and it can be used as vertical columns placed under compression but has little value as long horizontal beams unless it is strengthened.

Question 10
Describe two ways of strengthening concrete so that it can be used in beams.

3 marks

Suggested Solutions VCE Physics 2007 Unit 3 Written Examination 1

Section A–Core	Suggested marking scheme
Area of Study 1–Motion in one and two dimensions	
Question 1	
Use;	1
$v_{M/J} = v_M - v_J$	
take down as positive;	
$v_{M/J} = 1.5 - (-1.5)$	1
$v_{M/J} = 3.0 \text{ m s}^{-1}$	
Question 2	
For the escalator:	
$v = 1.5 \ m\ s^{-1}$	
$t = 60\ s$	
$\chi = \text{vt}$	1
$= 90\ m$	
The escalator is 90m long.	
With Joe walking on the moving escalator:	
$\chi = 90\ m$	
$v = 2.5 ms^{-1}$	1
$t = \frac{\chi}{v}$	1
$= 36\ s$	
Question 3	
Use: Eric has a mass of 30 kg.	
$F_{net} = 400 - 300\ N$	1
$= 100\ N$	
$a = \frac{F}{m}$	1
$a = \frac{100}{30}$	1
$= 3.3 \text{ m s}^{-2}$	

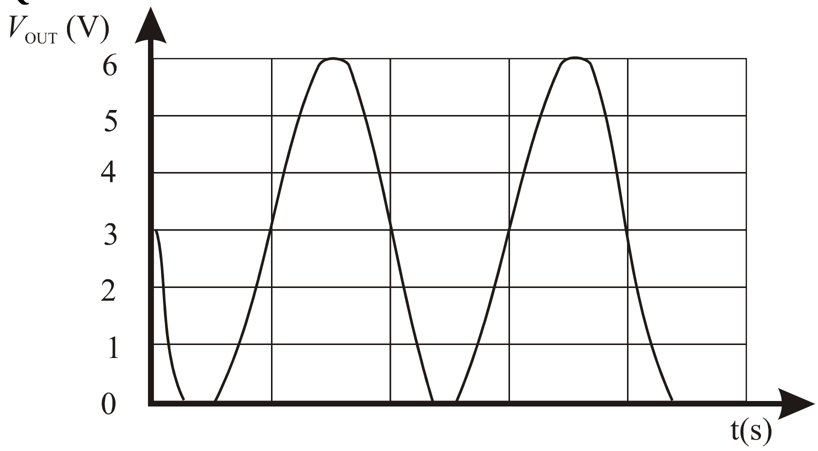
Question 4	
Given;	
$u = 20\,\text{m}\,\text{s}^{-1}$	
$\Delta t = 10\,\text{s}$	
$v = 5.0\,\text{m}\,\text{s}^{-1}$	
Use:	
$F\Delta t = m\Delta v$	
$F = \frac{m\Delta v}{\Delta t}$	1
$= \frac{900 \times (5.0 - 20)}{10}$	
$= -1350\,N$	1
The magnitude of the force acting is	
$= 1.4 \times 10^3$ N	
Question 5	1
Use: The tension in the string that is created by the circular motion must equal the weight of the larger mass.	
$\frac{mv^2}{r} = Mg$	
$v^2 = \frac{Mgr}{m}$	1
$v = \sqrt{\frac{0.90 \times 10 \times 0.80}{0.10}}$	
$v = 8.5\,\text{m}\,\text{s}^{-1}$	
Question 6	
To calculate the time of flight; first calculate the time to reach maximum height.	
Use: The vertical component.	
$v = u + at$	
$0 = 18\sin 45^0 - (10 \times t)$	1
$t = \frac{18\sin 45^0}{10}$	
$t = 1.27\ s$	
the time of flight is twice this value.	1
$t = 2.54\ s$	
$t = 2.5\ s$	
Question 7	1
First calculate the horizontal displacement of the ball.	
$x = vt$	
$= 18\cos 45^0 \times 2.54$	
$= 32.3\ m$	1
The receiver must cover (50-32.3) m in a time of 2.54 s	
$v = \frac{(50 - 32.3)}{2.54}$	1
$\text{speed} = 7.0\ \text{m}\,\text{s}^{-1}$	

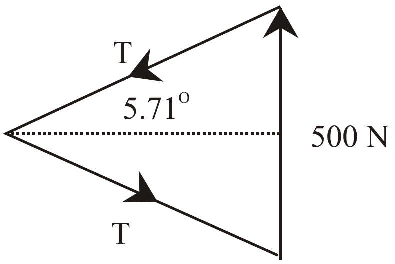
Question 8	
Use;	
$u = 0$	
$g = 10\,\mathrm{m\,s^{-2}}$	
$x = 3.0\,\mathrm{m}$	
to find v	
$v^2 = u^2 + 2gx$	1
$= 0 + (2 \times 10 \times 3.0)$	
$= 60$	1
$v = \sqrt{60}$	
$v = 7.7\,\mathrm{m\,s^{-1}}$	
Question 9	
Use the 1.0 m height as the reference (zero) position.	
U_g (lift) at top	1
$= U_s$ at full compression	
$2500 \times 10 \times 3.5 = \frac{1}{2} \mathrm{k} \times (0.5)^2$	1
$87500 = \frac{1}{2} \mathrm{k} \times 0.25$	
$\mathrm{k} = 7.0 \times 10^5\ \mathrm{N\,m^{-1}}$	1
Question 10	
Since the train is moving with a constant velocity, the horizontal net force is zero.	
$F_{DRIVING\ FORCE} + \Sigma F_{RESISTANCE\ FORCES} = 0$	1
$F_{DRIVING\ FORCE} = 2000 + 1500 + 1500$	
$= 5000\,\mathrm{N}$	1
$= 5.0 \times 10^3\ \mathrm{N}$	
Question 11	
To calculate the acceleration of the train;	
Consider the system as a whole;	
Total mass of the system: 40 tonnes	
Accelerating force =	1
$2.5 \times 10^4 - 5000 = 2.0 \times 10^3\ \mathrm{N}$	
$a = \frac{F}{m}$	
$= \frac{2.0 \times 10^3}{40000}$	1
$= 0.50\ \mathrm{m\,s^{-2}}$	

Answer	Marks
Question 12	
$\Sigma F_T = ma$	
Consider the forces on the carriage :	
$T_2 - 1500 = 10000 \times 0.20$	
$\therefore T_2 = 3500 N$	1
Consider the forces on the coal truck :	
$\Sigma F_{CT} = ma$	
$T - 3500 - 1500 = 10000 \times 0.20$	1
$\therefore T_1 = 7000 N$	
$= 7.0 \times 10^3$ N	1
Question 13	
The area under the graph of Force versus time is numerically equal to the magnitude of the impulse of the force.	
1 grid square = 0.50 Ns	1
Counting squares ≈11.5	
Area ≈ 11.5 × 0.50	
≈5.8 Ns	1
Question 14	
Using the previous answer:	
$F\Delta t = m\Delta v$	
$5.8 = 0.20(v - 0)$	
$v = \frac{5.8}{0.20}$	1
$v = 29 \text{ m s}^{-1}$	1
Question 15	
Use;	
$v = \frac{2\pi r}{T}$	1
$= \frac{2 \times \pi \times 7.7 \times 10^9}{3.09 \times 24 \times 3600}$	
$= 1.81 \times 10^5 \text{ m s}^{-1}$	
$= 1.8 \times 10^5 \text{ m s}^{-1}$	1
Question 16	
Since;	
$\frac{M_1 v^2}{r} = G\frac{M_1 M_2}{r^2}$	1
then,	
$M_2 = \frac{v^2 r}{G}$	
$= \frac{(1.81 \times 10^5)^2 \times 7.7 \times 10^9}{6.67 \times 10^{-11}}$	1
$M_2 = 3.78 \times 10^{30}$ kg	
$M_2 = 3.8 \times 10^{30}$ kg	

Question 17 Use; $F = \frac{GM_1M_2}{r^2}$	1
$= \frac{(6.67\times10^{-11})(3.78\times10^{30})(1.60\times10^{26})}{(7.7\times10^{9})^2}$ $= 6.8\times10^{26}$ N	1
Question 18 The planet in question is much closer to its parent star than Earth is to the Sun and the surface temperature on the planet would be very high … much higher than that of Earth.	1
Area of Study 2–Electronics and photonics **Question 1** $\frac{1}{R} = \frac{1}{10} + \frac{1}{10}$ $R = 5.0\,\Omega$	1
also, $\frac{1}{R} = \frac{1}{30} + \frac{1}{20}$ $R = 12\ \Omega$ The total resistance is then; $5.0 + 12 + 3.0 = 20\ \Omega$	1
The output voltage is across $15\,\Omega$ of resistance $V_{OUT} = \frac{15}{20}\times 60$ $= 45 V$	1
Question 2 Use; Current from the power supply : $I = \frac{v}{R}$ $\frac{60}{20}$ $= 3.0\ A$	1
For the $3.0\,\Omega$ resistor : Energy per second $= \mathrm{I}^2\mathrm{R}$ $= (3.0)^2 \times 3.0 = 27 W$ $\therefore$ 27 J is dissipated each second.	1
Question 3 The current of 60 mA means that the LED has reached its start-up voltage of 1.8 V.	1

Question 4 The current through the resistor is 60 mA. Use; $V = IR$	1
$= \frac{60}{1000} \times 250$ $= 15$ V	1
Question 5 The supply emf = 15 + 1.8 = 16.8 V =17 V	2
Question 6 Apart from a very small leakage current, the current in the circuit is essentially zero when the LED is in reverse bias.	2
Question 7 The voltage drop across the LED is 1.8 V. Since the 500 Ω resistor is in parallel with the LED, the voltage drop across it is also 1.8 V.	1
Use; $I = \frac{V}{R}$ $= \frac{1.8}{500}$ $= 3.6$ mA	1
Question 8 The correct answer is B.	2
Question 9 Since $V_1 = 0.90 V$ current in the $5.0 k\Omega$ resistor, $I = \frac{6.0 - 0.90}{5000}$	1
$= 1.02 \times 10^{-3}\ A$	1
this current also flows in resistor, R_2. $R_2 = \frac{0.90}{1.02 \times 10^{-3}}$ $= 882\ \Omega$ $= 0.88\ k\Omega$	1
(A voltage divider approach can also be used.)	
Question 10 Use the transfer characteristic graph to determine the value of V_{out}. Answer: $V_{out} = 6.0$ V	1

Answer	Marks
Question 11	
 	2
Question 12	
since $h_{FE} = 200$	
and $h_{FE} = \frac{I_C}{I_B}$	1
then; $I_C = 200 \times 5.0 \times 10^{-6}$	
$= 10^{-3}$ A	
$=1.0$ mA	1
then $\Delta V_{R3} = 10^{-3} \times 4\,700$	1
$= 4.7$ V	
Detailed study 2 – Investigating materials and their use in structures	
Question 1	
Use;	
$E = \frac{\text{stress}}{\text{strain}}$	1
$= \frac{20 \times 10^{6}}{1.0 \times 10^{-4}}$	
$= 2.0 \times 10^{11}$ N m^{-2}	1
Question 2	
The material with the greatest stiffness is A. Stiffness refers to the resistance of a material to stretch and is related to the gradient of the stress-strain graph.	2
Question 3	
Material C is the toughest. Toughness is related to the area under the stress-strain curve. A tougher material will absorb more energy before failing.	2
Question 4	
Use;	
Strain energy per volume is equivalent to the area under the graph.	
$= \frac{1}{2}(20 \times 10^{6}) \times (1.0 \times 10^{-4})$	1
$= 4\,000$ J m^{-3}	
$= 4.0 \times 10^{3}$ J m^{-3}	1

Question 5	
Use;	
$stress = \dfrac{F}{A}$	1
for the given maximum stress and area;	
$F = A \times stress$	1
$= 1.1 \times 10^{-6} \times 380 \times 10^{6} = 418\ \text{N}$	
Now, a load of 50 kg has a weight of 500 N.	
This value will provide a stress exceeding the elastic limit of the rod.	1
Question 6	
Resolve the 500 N force into two equal parallel components.	
Calculate angle θ;	
	
$\text{Tan}\,\theta = \dfrac{0.50}{5.0}$	
$\theta = \text{Tan}^{-1}(0.10) = 5.71^{0}$	1
Use;	
$\sin\theta = \dfrac{250}{T}$	
$T = \dfrac{250}{\sin 5.71^{0}}$	1
$= 2513\ \text{N} = 2.5 \times 10^{3}\ \text{N}$	1
Question 7	
Write an expression for the forces acting in the vertical direction.	
$\Sigma F_{VERT} = 0$	
$F_1 + F_2 - (600 \times 10) - (10\,000 \times 10) = 0$	1
$F_1 + F_2 = 106\,000\ N$	
The sum of the torques around a suitable point, say the point of application of F_1 is;	
$\Sigma\tau = 0$	
$\Sigma\text{cw}\ \tau = (6000 \times 5.0) + (10\,000 \times 10 \times 7.5)$	
$= 780\,000\ \text{N m}$	
$\Sigma\text{acw}\,\tau = -10 F_2$	
$\Sigma\text{cw}\ \tau + \Sigma\text{acw}\,\tau = 0$	
$F_2 = \dfrac{780\,000}{10}$	1
$F_2 = 78\,000\ \text{N}$	
$F_2 = 7.8 \times 10^{4}\ \text{N}$	
$F_1 = 106\,000 - 78\,000\ \text{N}$	
$F_1 = 28\,000\ \text{N}$	
$F_1 = 2.8 \times 10^{4}\ \text{N}$	1

Question 8	
Concrete stump B is clearly under compression;	
The compressive strength of concrete is $2.0\times10^{7}\ \text{N m}^{-2}$;	
The safety factor is 6.	
The maximum allowable stress is therefore;	
$\frac{2.0\times10^{7}}{6}=3.33\times10^{6}\ \text{N m}^{-2}$	1
since; $stress=\frac{F}{A}$	1
$A=\frac{78\,000}{3.33\times10^{6}}$	
$=2.34\times10^{-2}\ \text{m}^{2}$	1
Question 9	
Use;	
$E=\frac{stress}{strain}$	
$E=\frac{F\,\Delta l}{A\,L}$	
$\Delta l=\frac{l}{E}\times\frac{F}{A}$	1
$\Delta l=(\frac{1}{2.0\times10^{10}})\times3.3\times10^{6}\ \text{m}$	
$\Delta l=1.65\times10^{-4}\ \text{m}$	
$\Delta l=0.17\ \text{mm}$	1
Question 10	
Concrete is weak in tension. Iron rods that are strong under tension can be embedded in the concrete, which give it stability, but cracking will still occur on the underside of the loaded beam (where the concrete is in tension).	1
Pre-stressed concrete contains iron rods, which are held under tension and imbedded during the pouring process.	1
When the concrete is set, the tension on the rods is released which then places the concrete under compression.	1