UNIT 3 PHYSICS 2006
WRITTEN EXAMINATION 1 - SOLUTIONS

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AREA OF STUDY 1 – MOTION IN ONE AND TWO DIMENSIONS

QUESTION 1

$F_{net} = ma$

$a = -\frac{0.3}{1.5} = -0.2\ ms^{-2}$

$F_r = -0.2 \times 6 = -1.2\ N$

Magnitude is 1.2

QUESTION 2

$W = Fx$

$x = 0.5(u + v)t = 2.925\ m$

$W = 3.51\ J$

QUESTION 3

Momentum is conserved.

$p_i = 6 \times 1.8 = 10.8\ kgm/s$

$p_f = (6 + m_c) \times 1.2$

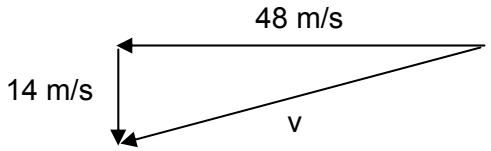
$m_c = 3\ kg$

QUESTION 4 C

$F_r = ma$ acceleration is the same for both, therefore, $F_r \infty m$.

QUESTION 5 A

QUESTION 6



Using Pythagora's Theorem: $v = 50\ m/s$

$\theta = Tan^{-1}\left(\frac{48}{14}\right) = 73.7^o$ Direction: $S74^oW$

QUESTION 7 50 m/s

QUESTION 8
Two acting forces: B (tension) and E (weight). Resultant: C.

QUESTION 9

$F_{net} = F_c = \frac{mv^2}{r} = 657\ N$

QUESTION 10

$U_x = 10\cos 37^o = 7.99\ m/s$

QUESTION 11

$d = 7.99 \times 1.48 = 11.82\ m$

QUESTION 12
This can be done a number of ways including "conservation of energy" or finding the final velocity components and using Pythagora's.

$v = 11.67\ m/s$

QUESTION 13 C
(C takes gravity and air resistance into account).

QUESTION 14

$g = \frac{F}{m} = \frac{4000}{8250} = 0.485\ N/kg$ (0.48, 0.49 or 0.5 acceptable)

QUESTION 15
ΔPE = area under graph = $5.6 \times 10^{11}\ J$ (accept range 5.3 to 5.9)

QUESTION 16

$KE_i = 7.30 \times 10^{11} J$ $KE_f = 1.29 \times 10^{12} J$

$v = 1.77 \times 10^4\ m/s$

AREA OF STUDY 2: ELECTRONICS AND PHOTONICS

QUESTION 1 45 mA

QUESTION 2 D

QUESTION 3 22.5 mA

QUESTION 4

$P = V\,I = 1.5 \times 0.0225 = 34\ \ mW$

QUESTION 5 10,000 ohms

QUESTION 6 2.7 V

QUESTION 7 34.4 kohm

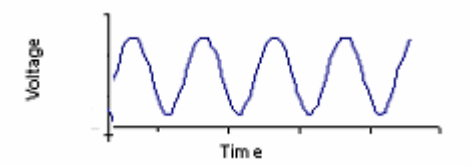
QUESTION 8
If R1 and the LDR were reversed, the night light would come on when light levels increase. This is the opposite to requirements.

QUESTION 9
If R1 was replaced with a variable resistor you could have the light switch on at different levels of darkness.

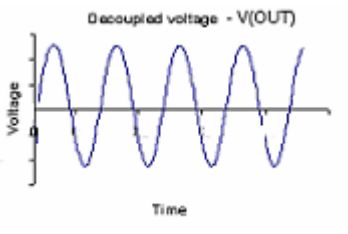
QUESTION 10
Approximately 200.

QUESTION 11
An inverting amplifier because a positive change of input produces a negative output.

QUESTION 12



QUESTION 13



QUESTION 14 B

DETAILED STUDY 1 - EINSTEIN'S SPECIAL RELATIVITY

QUESTION 1
Velocity, in all inertial reference frames, slower.

QUESTION 2 **B**

QUESTION 3

v is very small compared to c, γ = 1.000000083 $\left(\frac{1}{\sqrt{1-\left(\frac{50}{300,000,000}\right)^2}} \right)$

Therefore no observable effects.

QUESTION 4 **D**

QUESTION 5 **B**

QUESTION 6

$$\frac{v}{c} = \sqrt{\left(1-\left(\frac{t}{t'}\right)^2\right)} = \sqrt{1-\left(\frac{2.6\times10^{-8}}{5.96\times10^{-8}}\right)^2} = 0.9c$$

QUESTION 7

$d = vt = 0.9c \times 5.96\times10^{-8} = 16.1\,m$ (conseq)

QUESTION 8

$$m = \gamma m_o = \frac{m_o}{\sqrt{1-\left(\frac{v}{c}\right)^2}} = \frac{1.67\times10^{-27}}{\sqrt{1-(0.8)^2}} = 2.78\times10^{-27}\ kg$$

QUESTION 9 **B**

QUESTION 10

$$KE = \frac{1}{2}mv^2$$

$$v = \sqrt{2\left(\frac{KE}{m}\right)} = \sqrt{\frac{2\times5.34\times10^{-10}}{1.67\times10^{-27}}} = 8\times10^8 = 2.7c$$

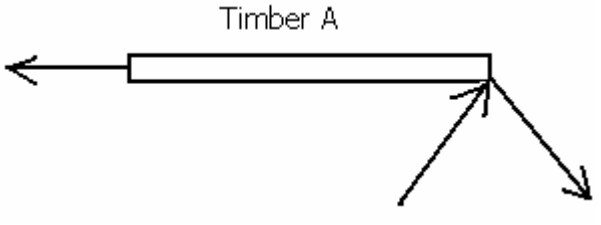
Answer is larger than *c* therefore not possible according to Einstein.

DETAILED STUDY 2 - INVESTIGATING MATERIALS AND THEIR USE IN STRUCTURES

QUESTION 1

Timber A: Tension
Timber B : Tension
Timber C: Compression
Timber D: Compression

QUESTION 2



QUESTION 3

The graph shows that the maximum compressive strength is 15 x 10^7 Nm^{-2}.

F = mg = stress x area

$$mass = \frac{stress \times area}{9.8} = \frac{15 \times 10^7 \times 0.02}{9.8}$$

Mass (max.) = 3.1 x 10^5 kg

QUESTION 4
Gradient of compressive region = 3.75 x 10^{10} Nm^{-2}

QUESTION 5
The compressive strength of the material is three times its tensile strength.

QUESTION 6 B

QUESTION 7
C is the most brittle because it fractures closest to its elastic limit.

QUESTION 8
A is the stiffest because has the least change in length for a given force.

QUESTION 9
D is the toughest as it demonstrates the greatest strain energy (area under the graph).

QUESTION 10

$\Sigma \tau = 0$

$-(3 \times 98) - (4.5 \times 784) + (6 \times F_2) = 0$
$-294 - 3528 + 6F_2 = 0$
$6F_2 = 3822$
$F_2 = 637N$

$\Sigma F = 0$

$F_1 - 98 - 784 + F_2 = 0$
$F_1 - 98 - 784 + 637 = 0$
$F_1 - 245 = 0$
$F_1 = 245N$

DETAILED STUDY 3: FURTHER ELECTRONICS SOLUTIONS

QUESTION 1

"A regulated power supply should be used to transform an alternating current supply into a **source of constant voltage/ half wave power supply/fully rectified power supply**.

A transformer is used to **increase/decrease/rectify** the supply voltage before it is placed across a **bridge rectifier/capacitor/load.**

A zener diode is used to complete the circuit. The zener diode is used in **forward biased orientation /reverse biased orientation/ inverted orientation."**

(1 mark per correct statement).

QUESTION 2

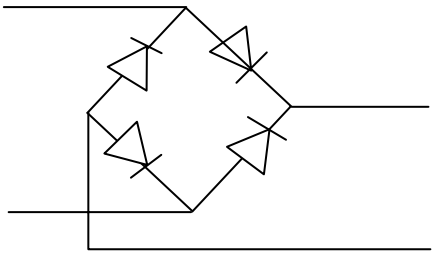
$$\frac{\text{Number of turns on the primary coil}}{\text{Number of turns on the secondary coil}} = \frac{V_P}{V_S} = \frac{240}{20} = 12$$

QUESTION 3 A

QUESTION 4 B
The amplitude will be slightly smaller due to diode's threshold voltage typically 0.6 V taken off per diode.

QUESTION 5 C
Only the reverse signal has been blocked.

QUESTION 6

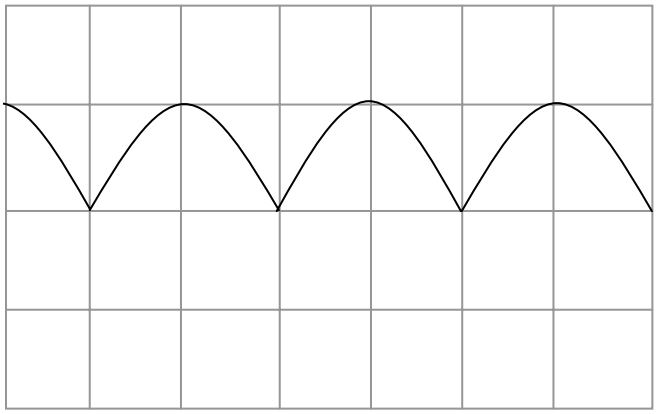


QUESTION 7

Time period $= 4 \times 0.5 \times 10^{-3} = 2 \times 10^{-3} s$ (1 mark)

Frequency $= \frac{1}{T} = \frac{1}{2} \times 10^{-3} = 500\ Hz$ (1 mark)

QUESTION 8



1 mark for fully rectified.
1 mark for reduced amplitude.

QUESTION 9

$\tau = C \times R = 40\ \Omega \times 50\ \mu F = 40 \times 50 \times 10^{-6} = 0.002\ s$ (1 mark)

$= 2\ ms$ (1 mark)

QUESTION 10

A clear decision cannot be made.

Since the time constant is only twice the discharge time, significant discharge will occur. While there will be some smoothing, there will also be significant ripple.

(1 mark for each point = 4 marks total).

QUESTION 11

A and C are correct (1 mark each = 2 marks total).

QUESTION 12

A and D are correct (1 mark each = 2 marks total).