

2012 Physics Trial Exam 1 Solutions

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Area of study 1 – Motion in one and two dimensions

Q1 $\sqrt{15^2 + 20^2} = 25 \text{ N}$, $\theta = \tan^{-1}(20/15) \approx 53^\circ$, S 53° W

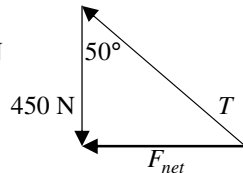
Q2 The reaction force consists of two components. They are the normal force and the force due to friction. $\sqrt{25^2 + 100^2} \approx 103 \text{ N}$

Q3 $2 \times 25 - F_f = 10 \times 1.5$, $F_f = 35 \text{ N}$

Q4 $\frac{450}{T} = \cos 50^\circ$, $T \approx 700 \text{ N}$, $k \approx \frac{700}{0.20} = 3500 \text{ N m}^{-1}$

Q5 $F_{\text{net}} = 450 \tan 50^\circ \approx 536.3 \text{ N}$

$a = \frac{536.3}{45} \approx 11.9 \text{ m s}^{-2}$



Q6 $11.9 = \frac{v^2}{2.0}$, $v \approx 4.9 \text{ m s}^{-1}$

Q7 Conservation of energy (gravitational potential energy and kinetic energy): $50 \times 10 \times 2.5 = \frac{1}{2} \times 50 \times v^2$, $v \approx 7.1 \text{ m s}^{-1}$

Q8 $R - mg = m \times \frac{v^2}{r}$, $R - 500 = 50 \times \frac{50}{3.0}$, $R \approx 1300 \text{ N}$

Apparent weight is 1300 N approx.

Q9 Same answer as Q7, i.e. 7.1 m s^{-1} (Conservation of energy)

Q10 The two balls are in free fall, $\therefore$ reaction force is zero.

Q11 $u = 0$, $a = -10$, $s = -2.0$, $v^2 = u^2 + 2as$,
 $v = \sqrt{40} \approx 6.3 \text{ m s}^{-1}$

Q12 Conservation of momentum:

$(1.0 + 0.10)u = 1.0 \times 4.0 + 0.10 \times 6.0$, $u \approx 4.2 \text{ m s}^{-1}$

Q13 Down motion: $v = -6.3$

Up motion: $u = +4.2$

Net impulse = $\Delta p = 1.1 \times +4.2 - 1.1 \times -6.3 \approx +11.6 \text{ N s}$

|Net impulse| $\approx 11.6 \text{ N s}$

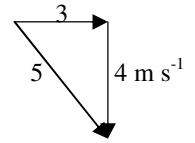
Q14 |Net impulse| = $F_{\text{average}} \Delta t$, $11.6 = F_{\text{average}} \times 0.020$

| F_{average} | $\approx 580 \text{ N}$

Q15

$u = 0$, $v = -4$, $a = -10$, $v = u + at$, $t = 0.4 \text{ s}$

$\therefore$ time of flight = 0.4 s



Q16 Horizontal displacement = $3.0 \times 0.4 = 1.2 \text{ m}$

Vertical displacement $s = \frac{1}{2}(u + v)t = \frac{1}{2}(0 + -4) \times 0.4 = -0.8 \text{ m}$

|Displacement| = $\sqrt{1.2^2 + 0.8^2} \approx 1.4 \text{ m}$

Q17 $g_m = g_E$, $\frac{g_m}{g_E} = 1$, $\frac{\frac{Gm_m}{PE^2}}{\frac{Gm_E}{PE^2}} = 1$,

$\frac{PE}{Pm} = \sqrt{\frac{m_E}{m_m}} = \sqrt{\frac{5.98 \times 10^{24}}{7.36 \times 10^{22}}} \approx 9$

Q18 $PE = \frac{9}{9+1} \times 3.82 \times 10^8 \approx 3.4 \times 10^8 \text{ m}$

Q19 $\frac{T_{\text{moon}}}{T_{\text{gs}}} = \frac{27}{1} = 27$

Q20 Since $\frac{r^3}{T^2}$ is a constant, $\therefore \frac{r_{\text{moon}}^3}{T_{\text{moon}}^2} = \frac{r_{\text{gs}}^3}{T_{\text{gs}}^2}$

$\therefore \frac{r_{\text{gs}}}{r_{\text{moon}}} = \left(\frac{T_{\text{gs}}}{T_{\text{moon}}} \right)^{\frac{2}{3}} = \left(\frac{1}{27} \right)^{\frac{2}{3}} = \frac{1}{9}$

$r_{\text{gs}} = \frac{1}{9} r_{\text{moon}} = \frac{1}{9} \times 3.82 \times 10^8 \approx 4.2 \times 10^7 \text{ m}$

Area of study 2 – Electronics and photonics

Q1 $V_{R1} = \frac{0.5}{1.5+1+0.5} \times 9.0 = 1.5 \text{ V}$

Q2 0

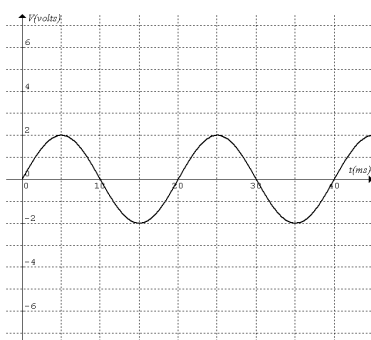
Q3 $V_{R2} = \frac{1}{1.5+1+0.5} \times 9.0 = 3.0 \text{ V}$, $V_p = -3.0 \text{ V}$

Q4 $\frac{P_3}{P_1} = \frac{I^2 R_3}{I^2 R_1} = \frac{R_3}{R_1} = \frac{1.5}{0.5} = 3$

Q5 When the LEDs are conducting, voltage across each one is 2.0 V. $\therefore$ max. voltage across 100Ω resistor = $6.0 - 2.0 = 4.0 \text{ V}$

Max. $I_{LED} = I_R = \frac{V}{R} = \frac{4.0}{100} = 0.040 \text{ A} = 40 \text{ mA}$

Q6



Q7 When L_2 is conducting, L_1 is reverse biased. When L_2 is not conducting, voltage across the resistor (and $\therefore L_1$) is zero. $\therefore L_1$ is off all the time. C

Q8 The lower one is R.

Q9 $\frac{R_{LDR}}{5k} = \frac{5}{4}$, $R_{LDR} = 6.25 \text{ k } \Omega$

Q10 $0 < I \leq 2.2$ units approx.

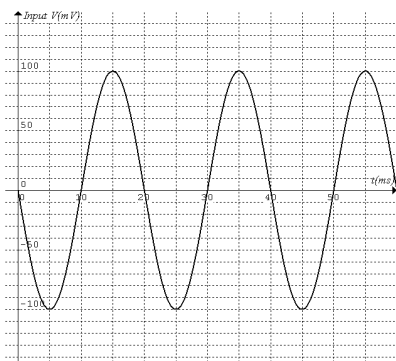
Q11 20 ms

Q12 Voltage gain = $\frac{v_o}{v_i}$, $-20 = \frac{1.5}{v_i}$, $v_i = -0.075 \text{ V} = -75 \text{ mV}$

Horizontal: 10 mV per division

Vertical: 0.5 V per division

Q13



Detailed study 2– Investigating materials and their use in structures

1	2	3	4	5	6
D	C	C	D	B	A

7	8	9	10	11	12
B	C	A	C	C	D

Q1 D

Q2 Stress = $\frac{(35+7.5) \times 10}{\pi \times 0.050^2} \approx 5.4 \times 10^4 \text{ N m}^{-2}$ C

Q3 C

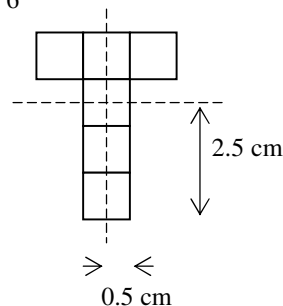
Q4 D

Q5 $T_B = 2 \times 800 \cos 25^\circ \approx 1450 \text{ N}$ B

Q6 $\epsilon = \frac{\sigma}{E} = \frac{\frac{1450}{\pi \times 0.005^2}}{200 \times 10^9} \approx 0.0001$ A

Q7 Centre of mass measured from the base:

$$y = \frac{1 \times 0.5 + 1 \times 1.5 + 1 \times 2.5 + 3 \times 3.5}{6} = 2.5 \text{ cm}$$



Tilt angle = $\tan^{-1} \left(\frac{0.5}{2.5} \right) \approx 11.3^\circ$ B

Q8 About the axis of rotation,

$\tau = 0.001 \times 10 \times 0.005 = 5 \times 10^{-5} \text{ Nm}$ C

Q9 Minimum torque required $> 1.2 \times 10 \times 0.05 = 0.60 \text{ Nm}$

$\tau_1 = 13 \times 0.05 = 0.65 \text{ Nm}$

$\tau_2 = 6 \times 0.10 = 0.60 \text{ Nm}$

$\tau_3 = (8 \cos 45^\circ) \times 0.10 \approx 0.57 \text{ Nm}$

$\tau_4 = (9 \cos 45^\circ) \times 0.10 \approx 0.64 \text{ Nm}$ A

Q10 C

Q11 Young's modulus $\approx \frac{230 \times 10^6}{0.003} \approx 80 \text{ GPa}$ C

Q12 D

Please inform physicsline@itute.com re conceptual, mathematical and/or typing errors