# 2012 Physics Trial Exam 1 Solutions



**Area of study 1 – Motion in one and two dimensions**

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

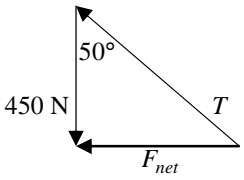
Q2 The reaction force consists of two components. They are the normal force and the force due to friction. $\sqrt{25^2+100^2}\approx 103\,\text{N}$

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

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

Q5 $F_{net}=450\tan 50°\approx 536.3\,\text{N}$

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




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, .: 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: $u=^{+}4.2$

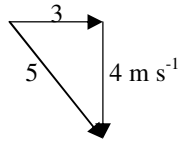
Net impulse $=\Delta p=1.1\times^{+}4.2-1.1\times^{-}6.3\approx^{+}11.6$ Ns

|Net impulse| $\approx 11.6$ Ns

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

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

Q15




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

.: time of flight $=0.4$ s

Q16 Horizontal displacement $=3.0\times 0.4=1.2$ m

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

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

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

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

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

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

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

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

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

## Area of study 2 – Electronics and photonics

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

Q2 0

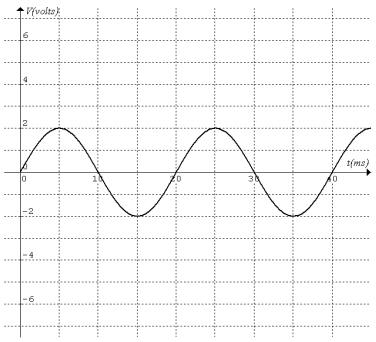
Q3 $V_{R2} = \dfrac{1}{1.5+1+0.5} \times 9.0 = 3.0 \text{ V}, \; V_P = -3.0 \text{ V}$

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

Q5 When the LEDs are conducting, voltage across each one is 2.0 V. .: max. voltage across 100 Ω resistor = 6.0 – 2.0 = 4.0 V

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

Q6




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

Q8 The lower one is R.

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

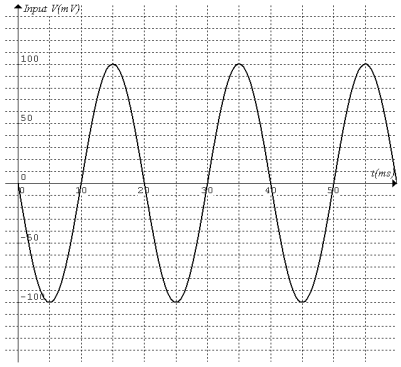
Q10 $0 < I \leq 2.2$ units approx.

Q11 20 ms

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

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

Q3 C

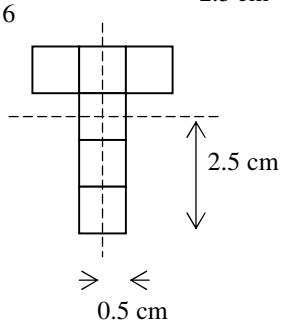
Q4 D

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

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

Q7 Centre of mass measured from the base:

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




Tilt angle $= \tan^{-1}\left(\dfrac{0.5}{2.5}\right) \approx 11.3°$ 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 $> 1.2 \times 10 \times 0.05 = 0.60 \text{ Nm}$

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

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

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

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

Q10 C

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

Q12 D

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