

Answers and mark scheme

1. (a) resistances of individual sections are $R, R/2, R/3$ (1)
 total resistance is therefore $(11/6)R$ (1)
 $(11/6)R = 22 \text{ k}\Omega$ (1)
 $R = 12 \text{ k}\Omega$ (1) [4]
- (b) calculate current I entering the network: $I^2 R = 0.0018 \text{ W}$ (2)
 $I = 0.388 \text{ mA}$ (1)
 current in (i) = 0.194 mA (1)
 power in (i) = 0.00045 W (0.45 mW) (1)
 power in (ii) = 0.2 mW (1) [6]
2. (a) pressure \times volume = constant for constant mass and temperature (1) [1]
- (b) initial pressure in air column = $(A + 100) \text{ mm Hg}$, (1)
 where A = atmospheric pressure in mm Hg (1)
 second pressure in air column = $(A - 100) \text{ mmHg}$ (1)
 apply Boyle's law: $(A + 100)(400) = (A - 100)(520)$ (1)
 solve for A ; $A = 767 \text{ mmHg}$ (1) [4]
- (c) (i) force = pressure \times area (1)
 area = $4\pi R^2 = 5.15 \times 10^{14} \text{ m}^2$ (1)
 magnitude = $(101 \times 10^3) \times (5.15 \times 10^{14})$ (1)
 $= 5.3 \times 10^{19} \text{ N}$ (unit required) (1) [4]
- (ii) divide result in (i) by g (1)
 mass = $5.3 \times 10^{18} \text{ kg}$ (unit required) (1) [2]
3. (a) $L = T^2 g / (4\pi^2)$ (1)
 $= 0.248 \text{ m}$ (expect three significant figures) (1) [2]
- (b) period with length $0.124 \text{ m} = 0.707 \text{ s}$ (1)
 new oscillation consists of two different half-periods (2)
 $T' = (0.500 + 0.353) \text{ s}$ (1)
 $= 0.853 \text{ s}$ (1) [5]
4. (a) $mc\theta$ (or similar) used. (1)
 $c = (2100 \times 240) / (1.50 \times 80)$ (1)
 $= 4200 \text{ J kg}^{-1} \text{ K}^{-1}$ (unit required: working must be shown) (2) [3]
- (b) mL (or similar) used (1)
 $L = (2100 \times 800) / 0.75$ (1)
 $= 2.24 \times 10^6 \text{ J kg}^{-1}$ (unit required): working must be shown (2) [3]
- (c) appreciation that volume and length are in a power 3 relation (1)
 ratio of volumes of steam and water = 1600 (1)
 ratio of mean separations = $(1600)^{1/3} = 11.7$ (2) [4]
5. (a) sensible time scale (e.g. $1 \text{ cm} = 1 \text{ s}$) (1)
 sensible speed scale (e.g. $1 \text{ cm} = 2 \text{ m s}^{-1}$) (1)
 correct speed-time line for stolen car (1)
 correct speed-time line for accelerating motor-cyclist (1)
 correct speed-time line for constant-speed motor-cyclist (1) [5]
- (b) appreciation that areas under the graphs represent distances travelled (1)
 method: (1)
 e.g. motor-cyclist attains maximum speed of 20 m s^{-1} after 5.0 s (1)
 distance travelled whilst accelerating = 50 m (1)
 distance travelled by car in this $5 \text{ s} = 75 \text{ m}$ (1)
 separation of car and motor-cyclist at this juncture = 25 m (1)
 subsequent relative speed = 5.0 m s^{-1} so motor-cyclist (1)
 reaches car 5.0 s later (1)
 total distance travelled by car in 10 s at $15 \text{ m s}^{-1} = 150 \text{ m}$ (1) [7]