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: $I^2 R = 0.0018$ W (2)
$I = 0.388$ 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 x volume = constant for constant mass and temperature [1]

(b) initial pressure in air column = $(A + 100)$ mm Hg,
where A = atmospheric pressure in mm Hg (1)
second pressure in air column = $(A - 100)$ mmHg (1)
apply Boyle's law: $(A + 100)(400) = (A - 100)(520)$ (1)
solve for A; $A = 767$ mmHg (1) [4]

(c) (i) force = pressure x 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)
$= 5.3 \times 10^{19}$ N (unit required) (1) [4]

(ii) divide result in (i) by g (1)
mass = 5.3×10^{18} kg (unit required) (1) [2]

3. (a) $L = T^2 g/(4\pi^2)$ (1)
$= 0.248$ m (expect three significant figures) (1) [2]

(b) period with length 0.124 m = 0.707 s (1)
new oscillation consists of two different half-periods (2)
$T' = (0.500 + 0.353)$ s (1)
$= 0.853$ s (1) [5]

4. (a) $mc\theta$ (or similar) used. (1)
$c = (2100 \times 240)/(1.50 \times 80)$
$= 4200\ \text{J kg}^{-1}\ \text{K}^{-1}$ (unit required: working must be shown) (2) [3]

(b) mL (or similar) used (1)
$L = (2100 \times 800)/0.75$
$= 2.24 \times 10^6\ \text{J kg}^{-1}$ (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 cm = 1s) (1)
sensible speed scale (e.g. 1 cm = 2 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:
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 s = 75 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 reaches car 5.0 s later (1)
total distance travelled by car in 10 s at 15 m s^{-1} = 150 m (1) [7]