இலங்கையின் உயர்தர கணித விஞ்ஞான பிரிவிற்கான இணையதளம்

# SCIENCE EAGLE
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| Grade :- 13 (2018) | Physics | Marking Scheme |
| --- | --- | --- |

## PART I (MCQ)

| | | | | |
| --- | --- | --- | --- | --- |
| (1) 4 | (11) 5 | (21) 5 | (31) 5 | (41) 2 |
| (2) 2 | (12) 4 | (22) 1 | (32) 4 | (42) 4 |
| (3) 3 | (13) 5 | (23) 2 | (33) 4 | (43) 3 |
| (4) 1 | (14) 2 | (24) 4 | (34) 1 | (44) 1 |
| (5) 2 | (15) 1 | (25) 2 | (35) 5 | (45) 1 |
| (6) 5 | (16) 4 | (26) 5 | (36) 1 | (46) 5 |
| (7) 4 | (17) 1 | (27) 1 | (37) 2 | (47) 3 |
| (8) 2 | (18) 5 | (28) 3 | (38) 4 | (48) 5 |
| (9) 1 | (19) 3 | (29) 3 | (39) 3 | (49) 4 |
| (10) 5 | (20) 4 | (30) 2 | (40) 2 | (50) 2 |

1.

(a)



$R_N$ (Normal Reaction)

$T = 5N$ (Tension by string)

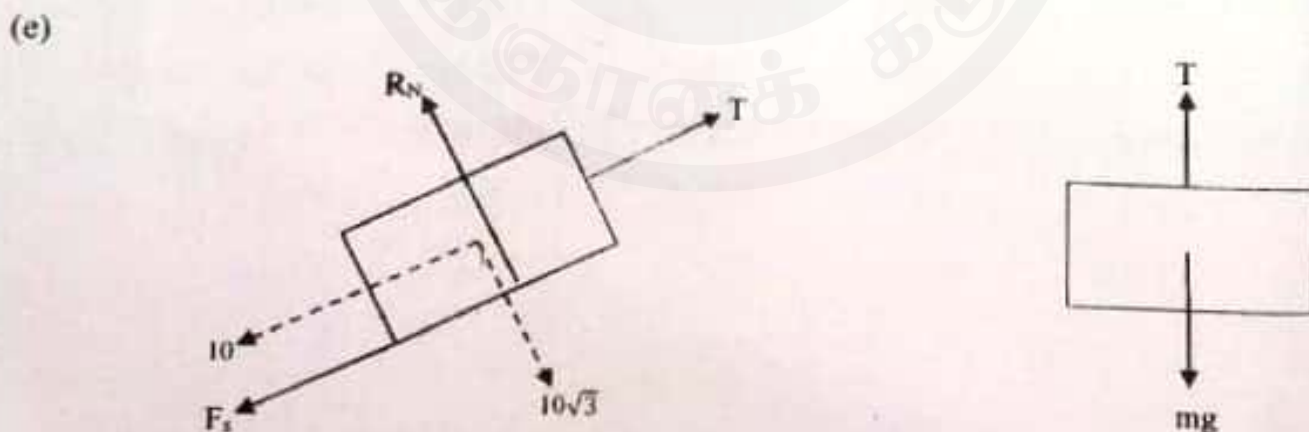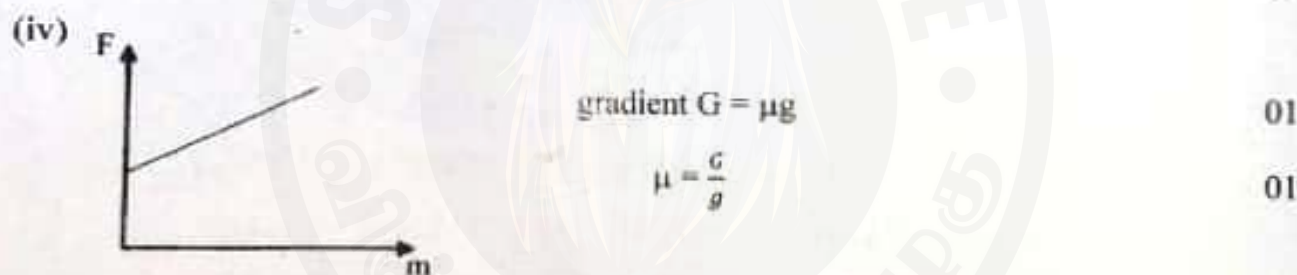$F_s$ (limiting frictional force)

20N (weight)

01
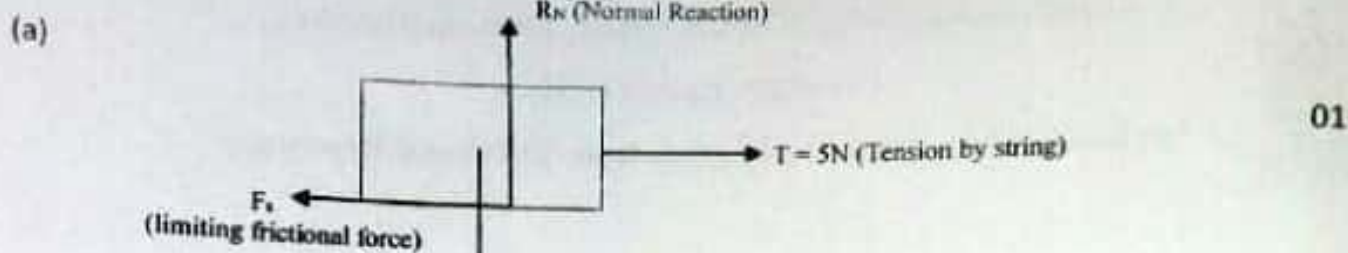
(b) $\mu_s = \dfrac{F_s}{R_N} = \dfrac{5}{20} = 0.25$

01

(c) 5N

01

(d) (i) Without additional mass take the reading of spring balance when the block is in verge of moving. Next add 100g mass on the block, pull the spring balance and take the reading when the block is in verge of moving. Take at least six set of readings.    01

(ii) $\mu = \dfrac{F}{W + mg}$

01

(iii) $\mu W + \mu mg = F$

$F = (\mu g)m + \mu W$

01

(iv)



gradient $G = \mu g$

$\mu = \dfrac{G}{g}$

01

01

(e)



$R_N$

T

$10$

$F_s$

$10\sqrt{3}$

T

mg

$F_s = 0.25 \times 10\sqrt{3} = 4.3N$

$T = 10 + 4.3 = 14.3N$

01

$14.3 = m \times 10$

$m = 1.43 \text{ kg}$

01

2

2.

(a) Thermometer (0-100°C), Thermometer (0-50°C), Beaker with water, wire gauze,

    Triple beam balance, Tripod and stirrer      01

(b) Place the calorimeter on an insulating support

    Close the calorimeter with lid

    Polish the outer surface

    Start the experiment 5°C below from room temperature and at 5°C above it.      01

(c) All lead shots attain same temperature

    It's a fixed temperature and high temperature      01

(d) Small - Water may not cover the metal balls completely      01

    Large - water may spill and increase in temperature may be too small      01

(e) Mass of empty calorimeter with stirrer      $= X_0$

    Mass of calorimeter + stirrer + water      $= X_1$

    Initial temperature of water      $= Y_1$

    Maximum temperature of water      $= Y_2$

    Mass of calorimeter + stirrer + water + lead shots      $= X_2$      02

(f) $[X_0 C_0 + (X_1 - X_0)C_w](Y_2 - Y_1) = (X_2 - X_1)C(100 - Y_2)$      01

(g) Water should not splash

    Reduce the heat loss to the surrounding      01

(h) $S = \dfrac{1200}{0.15 \times 60} = 133.3 \ \text{Jkg}^{-1}\text{K}^{-1}$      01


3.

(a) (i) longitudinal mechanical wave      01

    (ii) only transverse waves can be polarized but sound waves are longitudinal      01

(b) Due to interference standing wave is formed      01

    Maxima - Constructive interference (antinode)

    Minima - destructive interference (node)      01

    At constructive interference waves are in phase

    At minima waves are in antiphase      01

(c) (i) $\dfrac{\lambda}{2} = 0.05$,    $\lambda = 0.1$ m      01

3

(ii) $v = 3300 \times 0.1 = 330$ m s$^{-1}$      02 (01 for unit)

(d) (i) There is no complete cancellation/ no total destructive interference    01
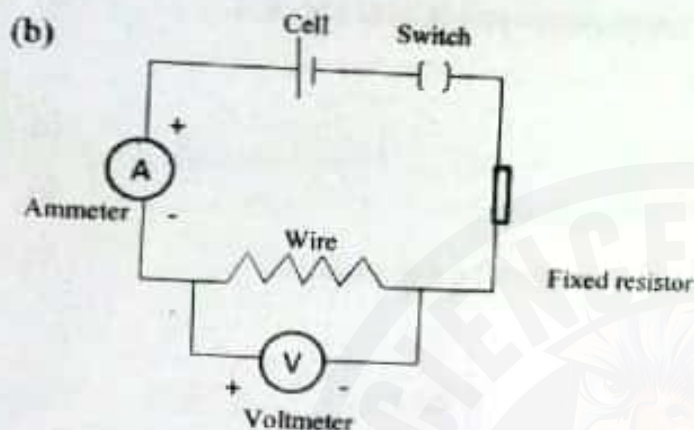
(ii) waves have different amplitudes. Amplitudes decrease with distance. Energy loss due to reflection.    01

4. (a) micrometer screw gauge      01

(b)



     01

     01

(c) (i) Fraction error $= \frac{1}{100} \times 100 = 1\%$

Fractional error $\leq 1\%$. It is better measurement.    01

(ii) $\alpha$ : voltmeter reading

$\beta$ : Ammeter reading

(iii) $R = \alpha/\beta$    01

   01

(d) (i) $R = \frac{\rho}{LA}$

$$R = \left(\frac{\rho}{A}\right)l$$
$$\downarrow \quad \downarrow\downarrow$$
$$y = m \ x$$

   01

It is in the form of y=mx

At constant temperature $\left(\frac{\rho}{A}\right)$ constant

(ii) $41.9 = \frac{\rho}{3 \times (0.06 \times 10^{-3})^2}$

   01

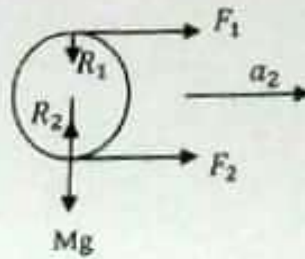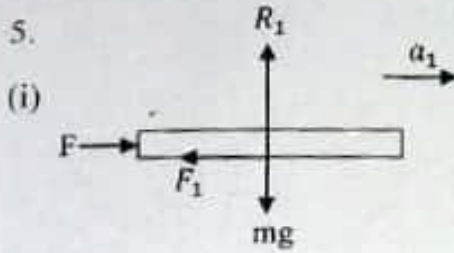$\rho = 41.9 \times 3 \times 10^{-10} \times 36 = 4.5 \times 10^{-7}$ $\Omega$m

(e) Diameter is measured only once

Voltmeter takes current to show reading    01

   01

4

5.

(i)



01

(ii) $a_1 = 2a_2$     01

(iii) plank $F - F_1 = ma_1 \Rightarrow a_1 = \dfrac{F-F_1}{m}$

Cylinder $F_1 + F_2 = Ma_2 \Rightarrow a_2 = \dfrac{F_1+F_2}{M}$     01

     $F_1$ - friction between plane and cylinder

     $F_2$ - friction between cylinder and floor

(iv) $\tau = I\alpha$

   $(F_1 - F_2)R = \left(\dfrac{1}{2}MR^2\right)\alpha$

   $\alpha = \dfrac{2(F_1-F_2)}{MR}$     01

(v) no slipping $a_2 = R\alpha = \dfrac{2(F_1-F_2)}{M}$     01

     Solving the above equations

   $a_1 = \dfrac{8F}{3M+8m}$     01

   $a_2 = \dfrac{4F}{3M+8m}$     01

(vi) $f_1 = F - ma_1 = \dfrac{3MF}{3M+8m}$     01

   $f_2 = \dfrac{MF}{3M+8m}$

(b) $F - 2F_1 - 500 = 100 \times 1$

   $F - 2F_1 = 600$     01

   $F_1 - F_2 - 100 = 20a$
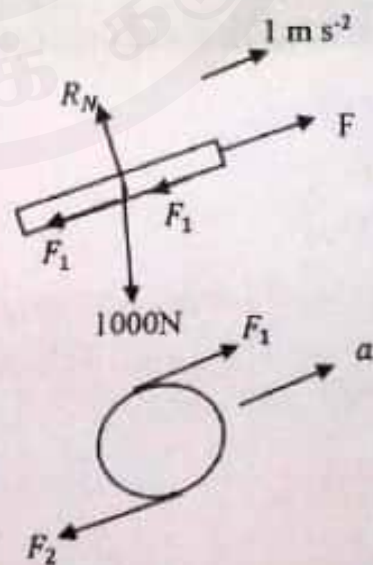
   $F_1 - F_2 = 100 + 20a$     01

   $(F_1 + F_2)0.1 = \left(\dfrac{1}{2} \times 20 \times 0.1^2\right)\alpha$     01

   $\alpha = F_1 + F_2$

   $a = 0.1\alpha$

   $F_1 - F_2 = 100 + 20 \times 0.1$

$$3F_2 + F_1 = -100$$ 01

$$a + R\alpha = 1$$

$$a + 0.1 \times \frac{a}{0.1} = 1 \implies a = 0.5\, ms^{-2}$$ 01

$$\alpha = \frac{0.5}{0.1} = 5\, rads^{-2}$$

$$F_1 + F_2 = 5$$

$$F_1 - F_2 = 110$$ 01

$$F_1 = 57.5\, N \qquad F_2 = -52.5\, N$$ 01

$$F = 2 \times 57.5 + 600 = 715\, N$$

**6.**

(a) (i) $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ 01

$$\frac{1}{-(d+40)} - \frac{1}{20} = \frac{1}{-16}$$ 01

$$d = 40\, cm$$

(ii)



01

(iii) $\frac{50}{r} = \frac{80}{40}$ 01

$$r = 25\, cm$$

(iv) $\Pi \times 0.5^2 \times I_1 \times \frac{95}{100} = \Pi \times 0.25^2 \times I_2$ 01

$$\frac{I_2}{I_1} = \frac{19}{5} = 3.8$$ 01
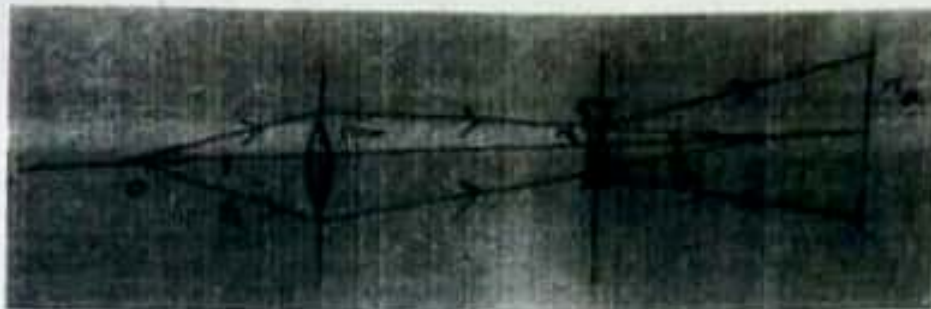
(b) (i) $\frac{1}{v} - \frac{1}{-50} = \frac{1}{+40}$ 01

$$v = 200\, cm$$ 01

from $L_2$ 2m

6

(ii)



01

(iii) $\frac{50}{r_1} = \frac{80}{50}$

01

$r_1 = 31.25\ cm$

01

(iv) $\frac{r_2}{r_1} = \frac{570}{200}$

01

$r_2 = 89.1\ cm$

(c) (i) reflection, refraction, interference and diffraction

01

(ii) Coherent, monochromatic, highly directional, high intensity

01

(iii) Population inversion

01

(iv) $2^n - 1$

01

7.

(a) (i) When one end of a solid is heated, the <u>molecules vibrate more strongly</u>. Whenever these molecules <u>collide with the neighbouring molecules</u>, the vibrational kinetic <u>energy is transferred</u> to the neighbouring molecules. This process is continued and heat is conducted through the solid.

02

(ii) Both involve a transfer of vibrational energy of the molecules in a medium

01

(b) (i) K - Thermal Conductivity

A - Cross sectional area <u>perpendicular</u> to the <u>flow of heat.</u>

$\frac{d\theta}{dx}$ - temperature gradient

01

(ii) The rod must be well lagged

Steady state must be attained

01

(c) (i)



01

No heat loss from the sides

01

7

(ii) $\frac{Q}{t} = KA\frac{(\theta_1-\theta_2)}{l}$ => $\frac{1}{A}\frac{Q}{t} = K\frac{(\theta_1-\theta_2)}{l}$ => $\theta_1 - \theta_2 = \frac{l}{KA}\frac{Q}{t}$

$30 - \theta_1 = \frac{1}{A}\frac{Q}{t}\left(\frac{2.00 \times 10^{-3}}{210}\right)$

$\theta_1 - \theta_2 = \frac{1}{A}\frac{Q}{t}\left(\frac{1.60 \times 10^{-2}}{0.024}\right)$  } 03

$\theta_2 - 0 = \frac{1}{A}\frac{Q}{t}\left(\frac{2.00 \times 10^{-3}}{210}\right)$

$30 = \frac{1}{A}\frac{Q}{t}\left(\frac{4.00 \times 10^{-3}}{210} + \frac{1.60 \times 10^{-2}}{0.024}\right)$

$\frac{Q}{At} = 45.0 \ Wm^{-2}$    01

(iii) Thickness of air layer is reduced, temperature gradient increases. Hence the rate of heat flow increases.    01

(iv) 'K' of metals are of the same order and are very high compared to air. Rate of heat flow almost same.    01

(v) Trapped air cannot move. Hence loss of heat by convection cannot take place.    01

(vi) heat is lost by convection    01

**8.**

(a) $\omega = 2\Pi f = 2 \times \Pi \times \frac{5000}{60}$    01

$\quad\quad = 524 \ rad \ s^{-1}$    01

(b) (i) $\omega = \frac{2\Pi}{24 \times 60 \times 60} = 7.3 \times 10^{-5} \ rad \ s^{-1}$    01

(ii) $a = r\omega^2$

$\quad = 6.4 \times 10^6 \times (7.3 \times 10^{-5})^2$    01

$\quad = 3.4 \times 10^{-2} \ m \ s^{-2}$    01

(c) (i)

at equator

$mg - F = mr\omega^2$

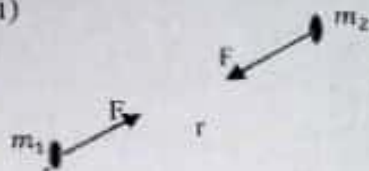$F = m(g-r\omega^2) = mg'$

$g' = g - r\omega^2$    01

at equator part of this 'g' has to provide the centripetal acceleration, the acceleration of free fall lower. But poles are not in circular motion    01

(ii) Earth's angular velocity is low.    01

At equator $g - g' = R\omega^2 = 0.03$

(d) (i)



Gravitational force of attraction F between two point. Masses $m_1, m_2$ is directly proportional to the product of masses. And inversely proportional to the square of their separation r

01

$$F \propto \frac{m_1 m_2}{r^2}$$

(ii)



$$F = \frac{GMm}{r^2}$$

$$g = \frac{F}{m}$$

$$g = \frac{GM}{R^2}$$

01

(e) (i)



$$\frac{GMm}{r^2} = mr\omega^2$$

01

$$r^3 = \frac{GM}{\omega^2} = \frac{gR^2}{\omega^2}$$

$$r^3 = \frac{10 \times (6.4 \times 10^6)^2}{(7.3 \times 10^{-5})^2}$$

$$r = 4.2 \times 10^7 \text{ m}$$

01

(ii) 1. Satellite lies on a plane containing the earth's equator and is always directly above a point on the equator

01

2. The satellite rotates from west to east, the earth's direction of rotation.

(f) Polar - satellites in low orbits are closer to earth, signals are received more strongly. 01

Geostationary - Continuous transmission between the ground station and the satellite, since they are always at the same spot above the equator 01

9.

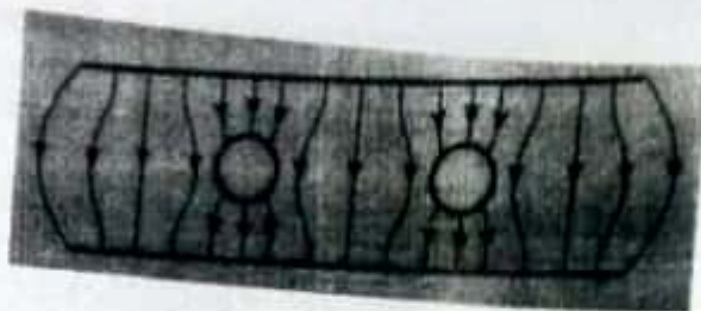(a) (i) Electrostatic force per unit positive charge placed at that point in the field. 01

(ii) Magnitude of 'E' is equal at all points and direction at every point is same. 01

(iii) Connect a battery across a pair of parallel conducting plates.
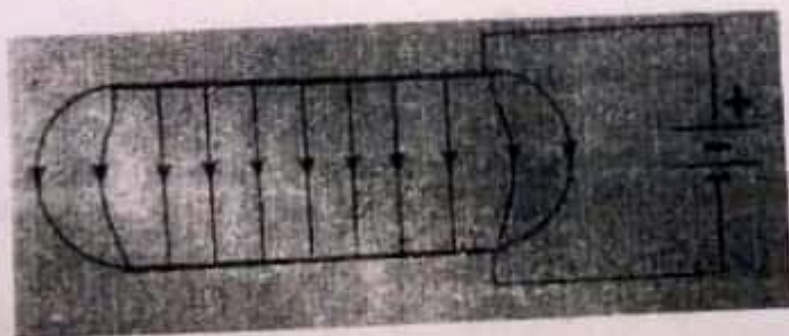


01

**(b) (i)**



01

**(ii)**



01

(iii) The conductor must either be charged or close to another charged object so that a large electric field would exist near the conductor. This would occur near the <u>pointed end</u> where a high potential difference would exist between the pointed end and some nearby object.　01

**(c) (i)** $F = qE$

$W = qE \times d$

$= +qEd$　01

**(ii)** $V = \dfrac{W}{q} = \dfrac{qEd}{q} = Ed$　01

**(d) (i)** $n = \dfrac{8.6 \times 10^{-3} Cs^{-1}}{1.6 \times 10^{-19} C}$　01

$n = 5.4 \times 10^{16} \, s^{-1}$　01

(ii) Gain in Kinetic energy = loss in electrical potential energy

$\dfrac{1}{2} mv^2 = eV$　01

$v = \sqrt{\dfrac{2eV}{m}} = \sqrt{\dfrac{2 \times 1.6 \times 10^{-19} \times 60 \times 10^3}{9.11 \times 10^{-31}}}$

$v = 1.45 \times 10^8 \, m \, s^{-1}$　01

(iii) energy = 60 keV

Power = $5.4 \times 10^{16} \times 60$ keV $s^{-1} = 5.4 \times 10^{16} \times 60 \times 10^3 \times 1.6 \times 10^{-19} = 517$ W　01

**(e) (i)** $E = 9 \times 10^9 \times \dfrac{0.060 \times 10^{-6}}{(0.10)^2} = 5.4 \times 10^4 \, NC^{-1}$　01

**(ii)** $V_B - V_C = V_A - V_B$

$$\frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r_B}-\frac{1}{r_C}\right]=\frac{q}{4\pi\varepsilon_0}\left[\frac{1}{r_A}-\frac{1}{r_B}\right]$$

$$\frac{1}{0.50}-\frac{1}{r_C}=\frac{1}{0.40}-\frac{1}{0.50}$$

$$r_C = 0.67m$$

01

10.

(a) (i) One volt is the potential difference between two points in a circuit if one joule of energy is converted from electrical to non-electrical form per Coulomb of positive charge flowing between two points.                                                01

(ii) Work done to take one Coulomb positive charge from negative terminal to positive terminal through the cell is e.m.f.

Work done to take unit positive charge from positive terminal to negative terminal through external circuit is potential difference                                    01

(b) (i) Q = 0.24 x 5 x 60 = 72 C                                                          01

(ii) EQ = 1.5 x 72 = 108 J                                                               01

(iii) Energy loss in 'r' = $I^2rt$ = 0.2rt = $0.24^2$ x 0.25 x 5 x 60 = 4.32 J         01

Energy transferred in 'R' = 108 - 4.3 = 103.7 J                                        01

(iv) R = $\frac{103.7}{4.32}$ x 0.25 = 6.0 $\Omega$                                    01

(c) (i) $R = \frac{1.5+1.5}{0.41} = 7.32\Omega$                                        01

New R = 7.32 - (0.25+0.25) = 6.82 $\Omega$                                             01

(ii) Current causes more heating an increase in amplitude of vibrations. More collisions. This increases resistivity.                                              01

(d) (i) The external loads will have a minimum total resistance of 3800 $\Omega$ (20°C)

Internal resistance 0.5 $\Omega$ ≪ 3800 $\Omega$                                      01

(ii) 0°C,  $V_1 = \frac{4000}{6000}$ x 3 = 2.0V                                        01

0°C, $V_2 = \frac{1800}{3800}$ x 3 = 1.4V                                              01

(iii) $\frac{R}{4000+R}$ x 3 = 1.2

R = 2670$\Omega$

$\frac{R}{1800+R}$ x 3 = 2.4                                                           01

R = 7200 $\Omega$

There is no single value for R that satisfies both conditions.                         01