**Name of the Student**:_____
**Max. Marks : 20 Marks** **Time : 20 Minutes**

Mark Schemes

## Q1.

(a) (device in which) an input of work ✔

(causes) heat to transfer from a cold space / reservoir to a hot space / reservoir ✔

*Answer must indicate that work is input OR done on working substance.*

**2**

(b) $Q_H$ is energy into the hot space / reservoir / space to be heated

**1**

(c) $0.5 = \frac{(T_H - T_C)}{T_H}$ ✔

$COP_{HP} = \frac{T_H}{T_H - T_C} = \frac{1}{0.5} = 2$ ✔

**2**

**[5]**

## Q2.

(a) (Gravitational potential energy of falling mass) is converted to linear/translational ke of mass and rotational ke of wheel ✓

**1**

and internal energy in bearings / air around wheel ✓

**1**

(b) (Use of $mgh = ½mv^2 + ½I\omega^2 + T\theta$ )

$mgh = 2.94\ J$

$(0.200 \times 9.81 \times 1.50) = (0.5 \times 0.200 \times 2.22^2) + (0.5 \times I \times 6.73^2)$

$½mv^2 = 0.493\ J$

$+ (7.5 \times 10^{-3} \times 4.55)$

$T\theta = 0.0728\ J$

$E_P$ or $E_K$ correct ✓

**1**

*If friction torque not worked out out, give up to max 2 marks. Give full marks if friction torque worked out and stated as negligible.*

All $E_P$, $E_K$ and $T\theta$ correct ✓

**1**

Leading to $I = 2.41(3) / 22.6$ ✓ ( = 0.107 kg $m^2$ )

*Gives*

$I = 0.108$ kg $m^2$

**1**

(c) $\alpha = T / I = 7.5 \times 10^{-3} / 0.107 = 0.0701$ rad $s^{-2}$ ✓

**1**

substitution of $\omega_2 = 0$, $\omega_1 = 6.73$ and α into $\omega_2^2 = \omega_1^2 - 2\alpha\theta$

leading to $\theta = 323$ rad ✓

**OR**

$\frac{1}{2} I\omega^2 = T\theta$ $\quad 0.5 \times 0.107 \times 6.73^2 = 7.5 \times 10^{-3}\ \theta$ ✓

$\theta = 323$ rad ✓

*Give CE if*

*$I = 0.108$ kg $m^2$ used*

**1**

**[7]**

## Q3.

(a) The (total) angular momentum (of a system) remains constant provided no external torque acts (on the system) ✓

*Do not accept 'force' in place of 'torque'*

**1**

(b) $I$ is the sum of the $m r^2$ products for point masses $m$ at radius $r$ ✓

*Or WTTE*

*Not m is the mass and r the radius – must refer to point or small masses or distribution of mass*

OR

$\Sigma\, m r^2$ with $m$ and $r$ defined

OR

$I$ is a measure of the mass and the way the mass is distributed about an axis

**1**

More of the satellite's mass is at greater radius ✓

**1**

(Small change in $r$) gives large change in $r^2$, hence large change in $I$

OR even though $m$ of panels is small, much of $m$ is at a greater radius and radius is squared ✓

*For 2nd mark must refer to effect of $r^2$.*

**1**

(c) Angular momentum = 110 × 5.2 = 572 ✓

**1**

N m s **OR** kg $m^2$ $s^{-1}$ ✓

*accept*
*kg m$^2$ rad s$^{-1}$*

**1**

(d) (Use of conservation of ang momtm) $572 = 230 \times \omega_2$ ✓

**1**

$\omega_2 = 572 / 230 = 2.49$ rad s$^{-1}$ ✓

**1**

**[8]**