UNIT 4 ROTATIONAL MOTION (1)

(1) Each of the following represents a quantity which might be measured for a body undergoing some form of rotational motion.

A Angular acceleration

B Angular momentum

C Centripetal force

D Kinetic energy

E Moment of inertia about the axis of rotation.

Which of these is

a) zero for a body moving in a circle at constant speed

b) independent of the wind speed for the rigid sails of a working windmill

c) proportional to the torque applied to a frictionless flywheel as it is set in motion by an electric motor

(2) The key contains eight statements about rotational motion. Three of these statements are true and the rest are false. Select the three *true* statements. Pencil across *three* cells in row 13.

KEY for Q13

A Uniform motion in a circle can be maintained without a supply of energy.

B Uniform motion in a circle does not require any force.

C The rotational motion of a body cannot change if the vector sum of the external forces acting on the body is zero.

D The rotational motion of a body cannot change if the total external torque is directed along the axis of rotation.

E If the rotational state of motion of a body changes, there must be at least two external forces acting on it, pointing in different directions.

F The rotational state of motion of a body about the centre of mass cannot change if all the external forces act on lines that pass through the centre of mass.

G External torque can change both the plane of rotation and the angular speed of a rotating body.

H Any object of constant mass has a single, constant moment of inertia.

(3) A car accelerates uniformly from rest to 50 km per hour in 10 seconds. Assuming that the wheels do not slip and that the radius of the wheels is 0.25 m, what is $d\omega/dt$, the magnitude of their angular acceleration? Select the *one* correct value from the key. Pencil across *one* cell in row 14.

KEY for Q14

A 2.8 rad s^{-1}

B 5.6 rad s^{-1}

C 28 rad s^{-1}

D 56 rad s^{-1}

E 2.8 rad s^{-2}

F 5.6 rad s^{-2}

G 28 rad s^{-2}

H 56 rad s^{-2}

(4) A skater is spinning with her arms outstretched. When she lowers her arms to her sides her rate of rotation increases. This is associated with an *increase* in her

1 kinetic energy of rotation ?

2 angular momentum ?

3 moment of inertia ?

(5) Changes in which of the following could alter the moment of inertia of a rigid body?

1 Angular velocity

2 Axis of rotation

3 Distribution of mass

(6) A child of mass 35 kg is sitting on the seat of a swing, suspended from a rigid bar on ropes 2 m long. Estimate the moment of inertia of the child with respect to the bar about which the swing rotates. (You may model the child as a particle located 2 m away from the bar.) Select the *one* correct value from the key. Pencil across *one* cell in row 15.

KEY for Q15

A 0

B 35 kg m^2

C 70 kg m^2

D 140 kg m^2

E 2 450 kg m^2

F 4 900 kg m^2

(7) A flywheel of moment of inertia 2.0×10^3 kg m^2 comes to rest from an initial angular speed of 15 revolutions per second in 30 seconds. Assuming that the angular speed of the flywheel decreases at a constant rate, and that the only cause of the slowing down is friction from the shaft of the flywheel, calculate the magnitude of the frictional torque at the shaft. Select the *one* correct value from the key. Pencil across *one* cell in row 16.

KEY for Q16

A 1.0×10^3 N m

B 2.0×10^3 N m

C 3.1×10^3 N m

D 4.0×10^3 N m

E 6.3×10^3 N m

F Impossible to calculate because the mass of the wheel is not given.

(8) The moment of inertia of a homogeneous sphere of mass M and radius R about any central axis is $I = \frac{2}{5}MR^2$. When such a sphere rolls without slipping down an inclined plane, what is the *ratio* of its translational to its rotational kinetic energy? Select the *one* correct answer from the key. Pencil across *one* cell in row 17.

KEY for Q17

A The ratio cannot be calculated, because the values of R and M are not given.

B The ratio cannot be calculated, because the slope of the plane is not given.

C The ratio cannot be calculated, because the height through which the sphere rolls is not given.

D 1/10

E 2/5

F 5/4

(9)