

# BTEC HIGHER NATIONALS-UNIT ENGINEERING SCIENCE H1

## ASSIGNMENT 2.1 DYNAMICS

Assignment front sheet to be attached to assignment when submitted for assessment.

NAME: \_\_\_\_\_

I agree to the assessment as contained in this assignment. I confirm that the work submitted is my own work.

Agreed completion date \_\_\_\_\_

Signature \_\_\_\_\_ Date submitted \_\_\_\_\_

### Pass Criteria

Outcome	Assessment Criteria	Achieved
1. Investigate static and dynamic engineering systems.	Determine the behaviour of dynamic mechanical systems in which uniform acceleration is present	
	Determine the effects of energy transfer in mechanical systems.	
	Determine the behaviour of oscillating mechanical systems in which simple harmonic motion is present.	

### Grading Criteria

Grade	Descriptor	Achieved
MERIT	<ul style="list-style-type: none"> <li>Different methods used to process information regarding theories and laws relating to simply supported beams and circular shafts within static systems.</li> <li>Development and application of theories and laws relating to static engineering systems and applications of laws, principles and skills to calculations.</li> <li>Well presented coherent report that uses appropriate technical language accurately.</li> </ul>	
DISTINCTION	<ul style="list-style-type: none"> <li>Validity of static laws and principles are checked.</li> <li>Valid conclusions drawn from investigated theories and applications to the theoretical application are correct.</li> <li>Individual approach in presenting work coherently, using technical language fluently.</li> </ul>	

ASSESSOR

Grade Awarded: \_\_\_\_\_ Date: \_\_\_\_\_

Tutor Signature \_\_\_\_\_

INTERNAL VERIFICATION

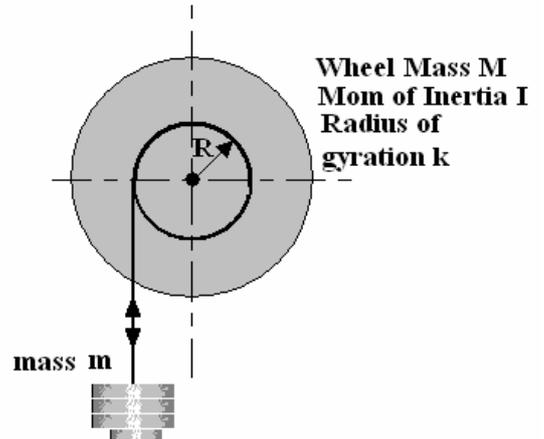
Brief IV YES/NO      Script IV YES/NO      Signature \_\_\_\_\_

Feedback Sheet

## DETAILS

### PART 1. LINEAR AND ANGULAR ACCELERATION

The diagram shows a wheel with a moment of inertia  $I$ . The wheel has a mass  $M$  kg and a radius of gyration  $k$  m. A cord is wrapped around the drum with a radius  $R$  m and a mass  $m$  kg is hung on the end. The mass is allowed to fall a distance  $s$  before it hits the ground. The acceleration of the mass ' $a$ ' m/s<sup>2</sup> is uniform. The corresponding angular acceleration of the wheel is ' $\alpha$ ' rad/s<sup>2</sup>.



The mass exerts a force on the cord of  $m(g - a)$ . The resulting angular acceleration is given by the following formula.

$$\alpha = \frac{mg}{\frac{I}{R} + mR}$$

*Analyse the forces acting on the system and write out a full derivation of this equation.*

Given a set of data from the table below, calculate the following.

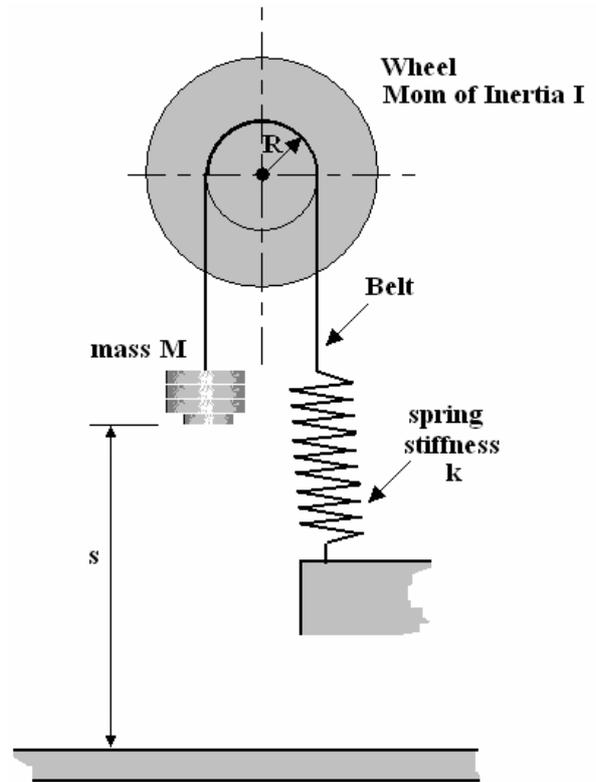
- *The angular acceleration of the wheel ' $\alpha$ '.*
- *The linear acceleration of the mass ' $a$ '.*
- *The velocity of the mass just before it hits the ground.*
- *The angular velocity of the wheel just before the mass hits the ground.*
- *The total potential (gravitational) energy in the system before the mass falls.*
- *The kinetic energy of the falling mass just before it hits the ground.*
- *The kinetic energy of the wheel just before the mass hits the ground.*
- *Show that the initial potential energy is equal to the final total kinetic energy.*

Explain what affect friction would have on the predicted velocities.

Student	M kg	K m	R (m)	M (kg)	s (m)
1	32	0.25	0.12	2.5	1.5
2	12	0.5	0.15	1.5	2
3	15	0.4	0.2	0.8	2.6
4	8	0.5	0.15	0.5	3
5	20	0.3	0.12	2	2.5
6	6	0.09	0.05	0.05	1.0
7	13	0.2	0.06	0.5	1.8
8	25	0.3	0.05	0.8	2.5
9	22	0.5	0.1	1.2	4
10	16	0.2	0.12	0.8	2.5

## PART 2   FREE VIBRATIONS

The diagram shows a wheel with a moment of inertia  $I$ . A mass  $M$  is connected to a belt and runs over a drum of radius  $R$ . The other end of the belt is attached to a spring of stiffness  $k$  that is connected to the ground.



### A. THEORY

Show that if the mass is pulled down with a force  $F$  and then released, that the system will oscillate with simple harmonic motion with a frequency given by

$$f = \frac{1}{2\pi} \sqrt{\frac{k}{M + \frac{I}{R^2}}}$$

*You will need to do the following.*

- *Show that the system meets the criteria for SHM*
- *Relate linear and angular quantities and change linear acceleration of the mass into angular acceleration of the wheel.*

### B. PRACTICAL

Set up an experiment with suitable equipment and verify if the formula accurately predicts the frequency.

*You will need to do the following.*

- *Calculate accurately the moment of inertia of the wheel.*
- *Determine the stiffness of the spring in a separate experiment.*
- *Measure the natural frequency of the combined system.*
- *Compare the predicted and measured frequencies.*

### C. ANALYSIS

- *Write a short dissertation on the energy changes taking place during the oscillation. Identify four forms of energy involved.*
- *Explain what affect friction would have on the oscillation.*
- *Produce an engineer's report with neat sketches and good communication to explain all of this. Pay attention to units and multiples. The conclusion is vital and must contain a critical analysis of all that you did.*