

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:		Student ID number:	
Programme:	BEng Engineering Programmes		
Module:	Engineering Science 1		
Module code:	M4X00385	Contribution to Overall Module Assessment (%):	30
Lecturer:	Abi Summerfield	Internal Verifier:	Tim Tudor
Assignment Title:	Energy in a Flywheel	Word count (or equivalent):	2000
Submission deadline:	13/12/2019	Return date of provisional marks & written feedback:	31/01/2020
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

1. Identify and apply appropriate physical principles and relationships in the solution of engineering problems.
2. Manipulate equations to produce numerical values in engineering units.

TASK DESCRIPTION

Carry out the experiment for 'Energy in a Flywheel' using the 'Potential and Kinetic Energy Kit ES9' in the Engineering Science lab (IQ007).

Carry out all of the 'Experimental Procedure' attached to this brief.

GUIDANCE FOR STUDENTS IN THE COMPLETION OF TASKS

You should then write up your experiment and report on your findings. When writing up your experiment you should use photographs to aid your explanation, and use research to justify the validity of your experiment, calculations and results.

The write up should take the form of a detailed report and should include the following headings:

1. Introduction
2. Experimental Procedure
3. Results
4. Analysis
5. Conclusion
6. Evaluation
7. Further work

References &/ or Bibliography.

GUIDANCE FOR STUDENTS IN THE COMPLETION OF TASKS

NOTE: The guidance offered below is linked to the five generic assessment criteria overleaf.

1. Engagement with Literature Skills

Your work must be informed and supported by scholarly material that is *relevant* to and *focused* on the task(s) set. You should provide evidence that you have accessed an appropriate *range* of sources, which may be academic, governmental and industrial; these sources may include academic journal articles, textbooks, current news articles, organisational documents, and websites. You should consider the *credibility* of your sources; academic journals are normally highly credible sources while websites require careful consideration/selection and should be used sparingly. Any sources you use should be current and up-to-date, mostly published within the last five years or so, though seminal/important works in the field may be older. You must provide *evidence* of your research/own reading throughout your work, using a suitable referencing system, including in-text citations in the main body of your work and a reference list at the end of your work.

Guidance specific to this assessment: You must use some external sources to help with your explanation of principles and to justify any decisions you make with regard to conclusions, etc.

2. Knowledge and Understanding Skills

At level 4, you should be able to demonstrate knowledge of the underlying concepts and principles associated with your area(s) of study. *Knowledge* relates to the facts, information and skills you have acquired through your learning. You demonstrate your *understanding* by interpreting the meaning of the facts and information (knowledge). This means that you need to select and include in your work the concepts, techniques, models, theories, etc. appropriate to the task(s) set. You should be able to explain the theories, concepts, etc. to show your understanding. Your mark/grade will also depend upon the *extent* to which you demonstrate your knowledge and understanding.

Guidance specific to this assessment: Well explained processes will get you high marks here.

3. Cognitive and Intellectual Skills

You should be able to present, evaluate and interpret qualitative and quantitative data, in order to develop lines of argument and make sound judgements in accordance with basic theories and concepts of your subject(s) of study. You should be able to evaluate the appropriateness of different approaches to solving problems related to your area(s) of study and/or work. Your work must contain evidence of logical, analytical thinking. For example, to examine and break information down into parts, make inferences, compile, compare and contrast information. This means not just describing what! But also justifying: Why? How? When? Who? Where? At what cost? You should provide justification for your arguments and judgements using evidence that you have reflected upon the ideas of others within the subject area and that you are able to make sound judgements and arguments using data and concepts. Where relevant, alternative solutions and recommendations may be proposed.

Guidance specific to this assessment: Good quality calculations and excel data with a good methodology is essential.

4. Practical Skills

At level 4, you should be able to apply the basic underlying concepts and principles to evaluate and interpret these within the context of your area of study. You should be able to demonstrate how the subject-related concepts and ideas relate to real world situations and/or a particular context. How do they work in practice? You will deploy models, methods, techniques, and/or theories, in that context, to assess current situations, perhaps to formulate plans or solutions to solve problems, or to create artefacts. This is likely to involve, for instance, the use of real world artefacts, examples and cases, the application of a model within an organisation and/or benchmarking one theory or organisation against others based on stated criteria.

Guidance specific to this assessment: *Methodical experimental procedure, including well used images will get good marks here.*

5. Transferable Skills for Life and Professional Practice

Your work must provide evidence of the qualities and transferable skills necessary for employment requiring the exercise of some personal responsibility. This includes demonstrating: that you can communicate the results of your study/work accurately and reliably, and with structured and coherent arguments; that you can initiate and complete tasks and procedures, whether individually and/or collaboratively; fluency of expression; clarity and effectiveness in presentation and organisation. Work should be coherent and well-structured in presentation and organisation.

Guidance specific to this assessment: *You need to use the report writing handbook to get the best structure here, if you do this now and make an assignment template as instructed in class, this will save you time in future.*

STUDENT FEEDBACK FORM

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills		
Inclusion of external information [8 marks] Properly cited references [8 marks] Quality of references [4 marks]	20	
2. Knowledge and Understanding Skills		
	20	
3. Cognitive and Intellectual Skills		
Quality of Excel tables [10 marks] Quality of Graphical data [10 marks] Calculation of the gradient [10 marks]	30	
4. Practical Application Skills		
Explanation of experimental procedure in an easy to follow method [10 marks] Good use of images [5 marks]	15	
5. Transferable Skills for Life and Professional Practice		
As per the notes on page 2 of this assignment brief.	15	

Assessment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)

Late Submission Penalties (tick if appropriate)

Up to 1 week late (40% Max)

Over 1 week late (0%)

%

GENERIC ASSESSMENT CRITERIA

Level 4

In accordance with the Framework for Higher Education Qualifications, at the end of Level 4 students will be expected to have demonstrated knowledge of the basic underlying concepts and principles of a subject, and an ability to evaluate and interpret these within the context of that area of study. They should be able to present, evaluate and interpret qualitative and quantitative data in order to develop lines of argument and make sound judgements in accordance with basic theories and concepts of their subject(s) of study. They will have learned how to evaluate different approaches to solving problems; and will be able to communicate the results of their study/work accurately and reliably, and with structured and coherent arguments. They will be able to undertake further training and develop new skills within a structured and managed environment and will have the qualities and transferable skills necessary for employment requiring the exercise of some personal responsibility.

Level 4 Category	FAIL 0-29%	MARGINAL FAIL 30-39%	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)	EXCEPTIONAL (1 st / Distinction)
Engagement with literature (including reading, referencing, academic conventions and academic honesty)	Little or no evidence of reading and/or reliance on inappropriate sources. Views and findings mostly unsupported and non-authoritative. Referencing conventions used incoherently or largely absent.	Poor engagement with essential reading. No evidence of wider reading. Reliance on inappropriate sources, and/or indiscriminate use of sources. Heavily reliant on information gained through class contact. Inconsistent and weak use of referencing.	Engagement with a limited range of mostly relevant and credible sources but with some reliance on information gained through class contact. Some omissions and minor errors. Referencing conventions evident though not always applied accurately or consistently.	Engagement with an appropriate range of literature, including sources retrieved independently. Some over-reliance on texts rather than other sources. Referencing may show minor inaccuracies or inconsistencies.	Engagement with a wide range of literature, including sources retrieved independently. Selection of relevant and credible sources. Generally sound referencing, with no/very few inaccuracies or inconsistencies.	Engagement with an extensive range of relevant and credible literature. Consistently accurate application of referencing.	Exceptional engagement with an extensive range of relevant and credible literature. High-level referencing skills consistently applied.
Knowledge and understanding (Knowledge of the basic underlying concepts and principles of a subject.)	Major gaps in knowledge and understanding of the basic underlying concepts and principles of the subject matter. Inclusion of irrelevant	Gaps in knowledge of the basic underlying concepts and principles, with flawed or superficial understanding. Some significant inaccuracies	Limited knowledge and understanding of the basic underlying concepts and principles within the subject area.	Knowledge of the basic underlying concepts and principles is accurate with a good understanding of the field of study	Competent knowledge of the basic underlying concepts and principles. Exhibits very good understanding.	Excellent knowledge and understanding of the basic underlying concepts and principles of the subject.	Exceptional, detailed knowledge and understanding of the basic underlying concepts and principles

Level 4	FAIL	MARGINAL FAIL	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)	EXCEPTIONAL (1 st / Distinction)
Category	0-29%	30-39%	40-49%	50-59%	60-69%	70-84%	85-100%
	material. Substantial inaccuracies.	and/or irrelevant material.	Some elements may be missing.	but lacks depth and/or breadth.			
Cognitive and intellectual skills (Evaluate underlying concepts and principles of a subject and interpret qualitative and quantitative data in order to develop lines of argument and make sound judgements.)	Wholly or almost wholly descriptive work. Little or no evaluation of the underlying concepts and principles. Failure to develop arguments, leading to illogical or invalid judgements. Minimal or no use of evidence to back up views.	Largely descriptive work, with superficial evaluation of the underlying concepts and principles. Weak interpretation of data, flawed development of arguments and judgements. Information accepted uncritically, uses generalised statements made with scant evidence and unsubstantiated opinions. Ideas sometimes illogical and contradictory.	Limited attempt at evaluation of the underlying concepts and principles, tending towards description. Can interpret qualitative and quantitative data but with some errors. Some evidence to support emerging arguments and judgements but these may be underdeveloped or with a little inconsistency / mis-interpretation.	Good evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data, with minor errors. An emerging ability to use evidence to support the argument. Mostly valid arguments and logical judgements.	Sound evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data accurately. Ability to devise arguments using evidence to make mostly appropriate and valid judgements.	Excellent evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data accurately and with some insight. Excellent ability to devise arguments using evidence and make appropriate and valid judgements.	Exceptional evaluation of the underlying concepts and principles based on evidence. Outstanding interpretation of qualitative and quantitative data. Exceptional ability to devise arguments using evidence and make wholly appropriate and valid judgements.
Practical skills (Different approaches to solving problems in particular contexts.)	Limited or no use of taught, basic methods, materials, tools and/or techniques. Little or no appreciation of the context of the application. Very weak evidence of different approaches to	Rudimentary application of taught, basic methods, materials, tools and/or techniques but without consideration and competence. Flawed appreciation of	An adequate awareness and mostly appropriate application of basic methods, tools and/or techniques. Basic appreciation of the context of the application.	A good and appropriate application of basic methods, tools and/or techniques. Clear appreciation of the context of the application. Good evidence of different approaches to	A very good application of a range of basic methods, materials, tools and/or techniques. Very good consideration of the context of the application. Very good evidence of different	An advanced application of a range of taught, basic methods, materials, tools and/or techniques. The context of the application is well considered, and insightful. Excellent evidence of different	Exceptional levels of application and deployment skills in particular practical contexts. Outstanding identification of problems in particular contexts and formulation of

Level 4	FAIL	MARGINAL FAIL	SATISFACTORY (3 rd / Pass)	GOOD (2.2 / Pass)	VERY GOOD (2.1 / Merit)	EXCELLENT (1 st / Distinction)	EXCEPTIONAL (1 st / Distinction)
Category	0-29%	30-39%	40-49%	50-59%	60-69%	70-84%	85-100%
	problem-solving in particular contexts.	the context of the application. Weak evidence of different approaches to problem-solving in particular contexts.	Can identify problems in particular contexts and propose basic alternative approaches or solutions though there may be errors.	problem-solving in particular contexts and proposes mostly appropriate solutions.	approaches to problem-solving in particular contexts and proposes appropriate solutions.	approaches to problem-solving in particular contexts and proposes appropriate solutions.	wholly appropriate, thoughtful solutions / different approaches.
Transferable skills for life and professional practice (Communicate the results of their study/work accurately and reliably, and with structured and coherent arguments; the qualities needed for employment requiring the exercise of some personal responsibility within a structured and managed environment.)	Work is poorly structured, disorganised, inaccurate and/or confusingly expressed. Very weak use of language and/or very inappropriate style. Failure to work effectively individual or as part of a group. Little or no evidence of the skills for employment requiring the exercise of some personal responsibility.	Work is poorly presented in a disjointed manner. It is loosely, and at times incoherently, structured, with information and ideas often poorly expressed. Weak use of language and/or inappropriate style. Flawed approach to individual or group work, meeting only partial obligations to others. Limited evidence of the skills for employment requiring the exercise of some personal responsibility.	Mostly ordered presentation and structure in which relevant ideas / concepts are reasonably expressed. Work may lack coherence and/or accuracy in places. Can work as part of a group, meeting most obligations to others but perhaps with limited involvement in group activities. Demonstrates the basic skills for employment requiring the exercise of some personal responsibility, with some areas of minor weakness.	Mostly coherent, organised and accurate work, in a suitable structure and is clearly expressed. Can work effectively independently and/or as part of a team, with clear contribution to group activities. Demonstrates very good skills for employment requiring the exercise of some personal responsibility, with some areas of strength and some of minor weakness.	Work is accurate, coherent, fluent, well-structured and organised. Can work effectively independently and/or as part of a team, with very good contribution to group activities. Demonstrates very good skills for employment requiring the exercise of some personal responsibility, with just occasional minor weakness.	Work is coherent, very fluent and is presented professionally. Can work effectively independently and/or as part of a team, with an excellent contribution to group activities. Demonstrates excellent skills for employment requiring the exercise of some personal responsibility with an appetite for further development.	Work is accurate, exceptionally coherent, very fluent and presented well. Can work effectively independently and/or as part of a team, with an exceptional contribution to group activities. Demonstrates exceptional skills for employment requiring the exercise of some personal responsibility with an appetite for further development.

***Engineering Science
Worksheets***
***POTENTIAL AND KINETIC
ENERGY KIT ES9***
3. ENERGY IN A FLYWHEEL

Name	
Date	
Course/Year/Group	

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DB/1012



Energy in a Flywheel**Aims**

To prove the theory for energy in a flywheel.

Experiment Setup

As shown in Figure 1, fix the Bearing Block and Flywheel to the Work Panel. Count the holes in the Work Panel if you need to make sure everything fits correctly.

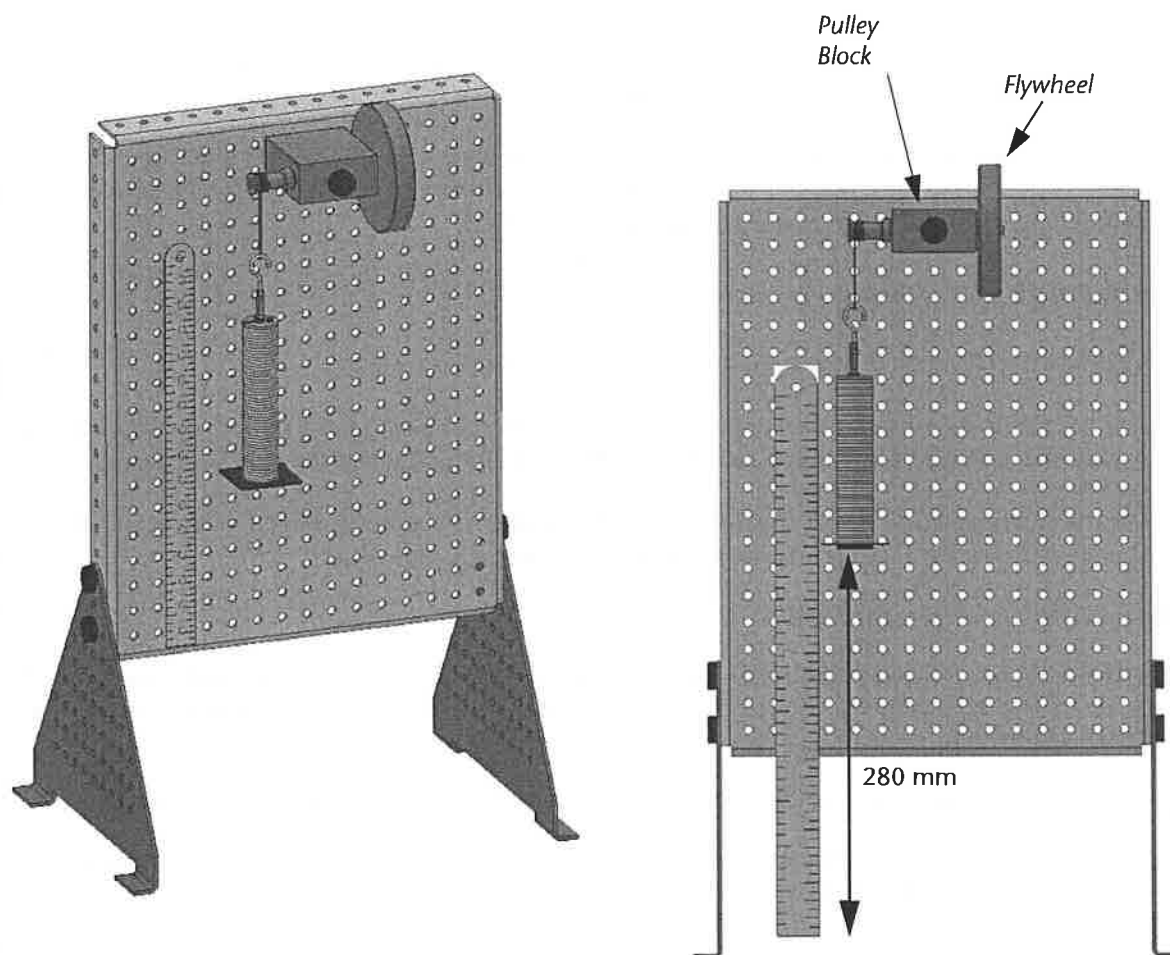


Figure 1 Experiment Setup

Experiment Procedure

1. Read the Guidance Notes (supplied).
2. Fit the plastic guide to the bottom of the Weight Hanger.
3. Your lecturer may have cut the cord to length for you. It should allow the bottom of the weight hanger to travel through a vertical drop of just under 290 mm.
4. Allow the Weight Hanger to fall to the bottom of its travel. Move the magnetic rule behind the Weight Hanger, so its 0 mm edge aligns with the plastic guide.
5. Add 90 g masses to give a total of 100 g on the Weight Hanger.
6. Slowly turn the flywheel to lift the weight hanger, (it doesn't matter which way) until the bottom of the weight hanger reaches 280 mm on the rule.
7. Use the stopwatch to measure how many seconds it takes for the Weight Hanger to fall from its 280 mm position to the 0 mm position and back up to its maximum height (h_2). Try this several times to get a good average value for the time and the height (h_2).
8. Calculate PE (mgh_1), the mg and PE loss (adjusted) values.
9. Calculate the falling time, acceleration, velocity, $(mg-ma)r$ and a/r values.
10. Add the nominal I values for the flywheel and the pulley in the bearing block to find the total nominal I value for the flywheel. Use this to calculate the KE value for the flywheel for each line of results.
11. Use the chart paper to create a chart of $(mg-ma)r$ against a/r . Your results should give a reasonably straight line with little scatter. Use the chart to find an average value I for the flywheel.

Questions and Conclusions

Note the relationship between the mass you apply and the PE loss. Heavier masses should give larger PE losses up to a certain point. Why do you think this happens? Hint - try the other Engineering Science Kits that deal with friction.

Compare your value of I from the chart with that of the nominal values. Do they compare well?

Given that the frictional losses become less significant at higher loads, think about other sources of error that show discrepancies in the equation: $PE + PE \text{ loss} = KE$

Mass m (kg)	PE mgh_1 (J)	Time to fall and rise t_f (seconds)	h_2 (m)	mg	PE loss Adjusted (J)	Falling Time t_f (seconds)	Acceleration a ($m.s^{-2}$)	Velocity v ($m.s^{-1}$)	Velocity ω ($rad.s^{-1}$)	$(mg-ma)r$	a/r	KE
0	0	0	0	0	0	0	0	0	0		0	0
0.1												
0.2												
0.3												
0.4												
0.5												

$h_1 = 280 \text{ mm (0.28 m)}$
 $r = 0.0065 \text{ m (allowing for the cord thickness)}$
Nominal $I =$

Table 1 Blank Results Table

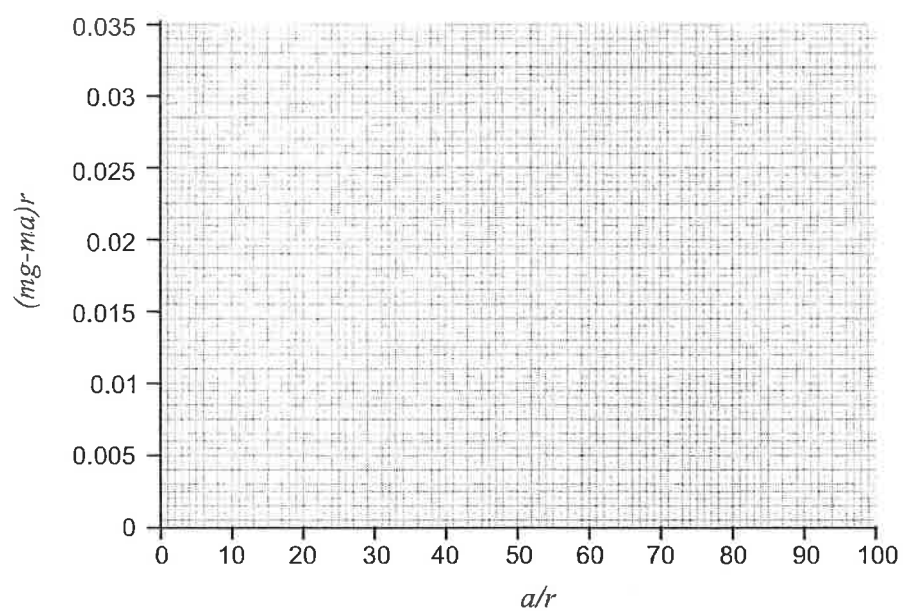


Figure 2 Blank Chart Paper

Engineering Science Guidance Notes

POTENTIAL AND KINETIC ENERGY KIT ES9

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DB/1012



The Flywheel Brake

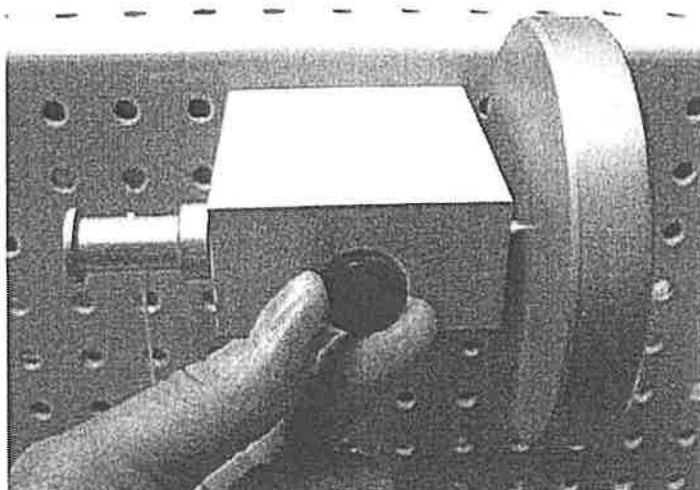


Figure 7 The Flywheel Brake

The Bearing Block has an extra thumbscrew to the front. This helps lock or 'brake' the flywheel shaft in position, which you may find useful during your experiments.

NOTE



Fully unscrew the brake by at least one turn to allow the flywheel to rotate, or your results will be wrong.

Nominal Details of Parts

You need to know the details of some of the parts used in the experiments. Table 2 gives the nominal values that you may use in your experiments. However, the weights may change slightly due to manufacturing tolerances. For more accuracy, you could ask your teacher or lecturer for an accurate weighing scale to measure the weights yourself.

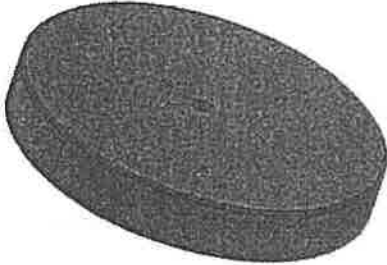
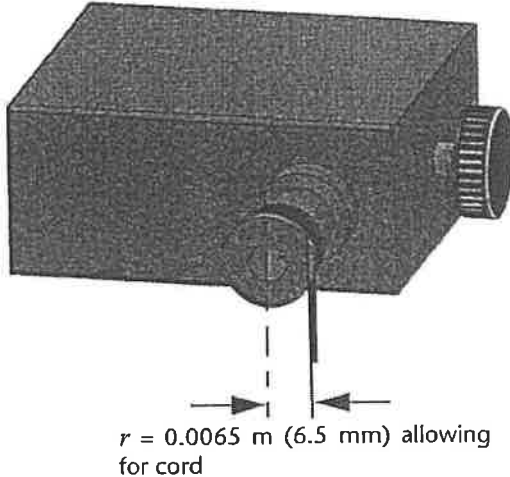
Part	Nominal Details
	330 g (0.330 kg) $I = 3.862 \times 10^{-4} \text{ kg.m}^2$
	60 g (0.06 kg)
 $r = 0.0065 \text{ m (6.5 mm)}$ allowing for cord	I for shaft and pulley $= 0.834 \times 10^{-4} \text{ kg.m}^2$ Allowing for the cord $r = 0.0065 \text{ m}$ $d = 0.013 \text{ m}$ $c = \pi \times 0.013 = 0.04084$

Table 2 Nominal Weights

Energy in a Flywheel

Kinetic energy can be 'stored' in the moving parts of a machine (such as a flywheel). The larger the mass or speed of the moving object, the more kinetic energy it can store. For a flywheel, its kinetic energy is equal to half the product of its moment of inertia and its angular velocity squared.

$$KE = 0.5I_f\omega^2$$

The **moment of inertia** (I_f) of the flywheel is its resistance to a change in rotation. You find the value from

$$I_f = 0.5m_f r^2$$

However, the true total moment of inertia (I_f) of the flywheel and its connected parts is very difficult to find as it equal to the sum of the moment of inertia of the flywheel (I_f), and an additional amount for the metal shaft, the pulley and part of the bearing race that the shaft turns in. These Guidance Notes give a nominal value and you can find an average value from experiment (see later).

The **angular velocity** (ω) is the velocity of the flywheel in terms of the angle that it passes through in a given second, with the units of radians. It is similar to revolutions per minute or per second, but one radian is equal to 57.3 degrees, while one revolution is 360 degrees.

Therefore:

One revolution per second = 6.28 radians per second

$$1 \text{ rev.s}^{-1} = 6.28 \text{ rad.s}^{-1}$$

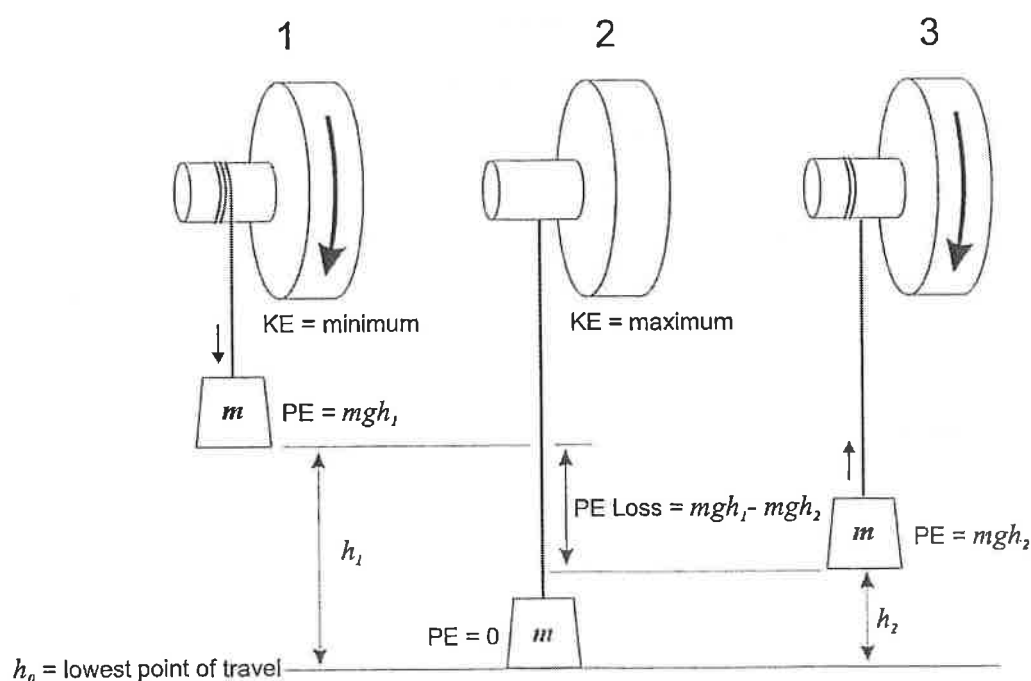


Figure 17 Energy in a Flywheel

See Figure 17. In step 1, the flywheel has not yet started to turn, so its Kinetic Energy $KE = 0$. The mass that turns the flywheel does so by giving up its initial potential energy (mgh_1) in turning the flywheel until it reaches the lowest point of its downwards travel (h_0) at step 2. At this point, the flywheel turns at its fastest

velocity and acceleration has reached a maximum. This is a conversion from potential energy into kinetic energy. Like the pendulum, the flywheel now continues using its kinetic energy to lift the mass back up (step 3).

If the mass returns back to its original height (h_1), then the flywheel will have given up all its kinetic energy back to the mass and $PE = KE$. However, some energy is lost in the bearings of the Bearing Block and other factors, so the mass will not return to its original height. Instead, it will reach a lower height (h_2). The loss is potential energy loss PE_{loss} .

$$PE_{loss} = mgh_1 - mgh_2$$

$$\text{or simplified } PE_{loss} = mg(h_1 - h_2)$$

The PE loss is the total loss through the downward and upward movement. To compare it more accurately with KE, which is for simply for the downward movement, you must multiply it by the height ratio, just as with the acceleration time (see later).

$$PE_{loss} (\text{adjusted}) = PE_{loss} \times h_1 / (h_1 + h_2)$$

Worked Example of Finding PE

Mass $m = 500 \text{ g}$ (0.5 kg)

$$g = 9.81 \text{ m.s}^{-2}$$

$$h_1 = 280 \text{ mm}$$
 (0.28 m)

$$PE = 0.5 \times 9.81 \times 0.28 = 1.37 \text{ J}$$

Worked Example of Finding PE loss

$$h_1 = 280 \text{ mm}$$
 (0.28 m) and $h_2 = 250 \text{ mm}$ (0.25 m)

$$m = 0.5 \text{ kg and } g = 9.81$$

$$PE_{loss} = 0.5 \times 9.81 \times (0.28 - 0.25) = 0.147 \text{ J}$$

$$PE_{loss} (\text{adjusted}) = 0.147 \times \{280 / (280 + 250)\} = 0.078 \text{ J}$$

Acceleration and Velocity of the Mass and Flywheel

The acceleration of the falling mass (and therefore flywheel) reaches a maximum at step 2, where the mass has fallen through a distance h_1 , over the square of a given time t_f taken for the fall:

$$a = \frac{h_1}{t_f^2}$$

However, it is difficult to measure this 'falling time' t_f accurately, so for better results you measure the total time (t_t) taken to fall from step 1 and rise to step 3 and multiply by the ratio $h_1 / (h_1 + h_2)$. Therefore, for this kit:

$$t_f = t_t \times \frac{h_1}{h_1 + h_2}$$

The maximum linear velocity v of the falling mass is then simply a product of its maximum acceleration and time, so:

$$v = at_f$$

The falling mass **linear** velocity (v) is the same as the **angular** velocity (ω) of the perimeter of the pulley and of course the flywheel (they are all connected), but you must convert the linear velocity into angular velocity, so using the perimeter (circumference) of the pulley:

$$\omega = \frac{2\pi v}{c}$$

Where $c = 0.0408$ m (allowing for the diameter of the cord on the pulley)

Finding I_f from experiment

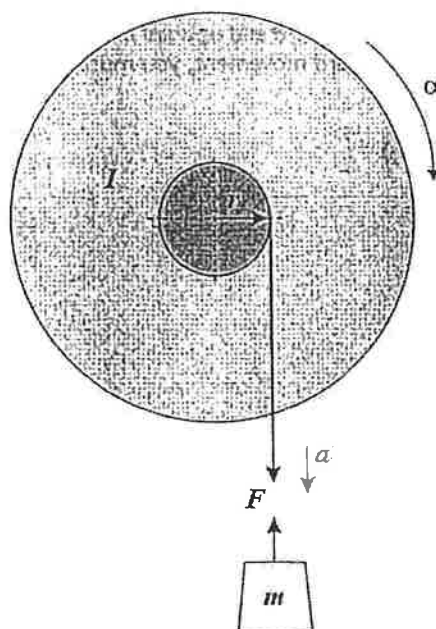


Figure 18 Acceleration and Inertia in a Flywheel

There are certain governing equations that the flywheel obeys, which you can use to find a reasonably accurate value for its total moment of inertia from experiment.

As shown in Figure 18, the force in the cord of a flywheel at any time is equal to the difference between the force created by the acceleration due to gravity on the mass (mg) and the force due to the accelerating mass (ma).

$$F = mg - ma$$

Assuming the cord does not stretch, then from simple moment theory, the torque in the cord is equal to the product of the force in the cord at the radius of the pulley.

$$\tau = Fr$$

$$\text{From this: } \tau = (mg - ma)r$$

NOTE



The radius of the pulley must allow for the thickness of the cord used.

The torque due to the turning flywheel is equal to the product of the flywheel angular acceleration and the moment of inertia of the flywheel.

$$\tau = I\alpha$$

The angular acceleration in the flywheel is equal to the acceleration of the moving mass divided by the pulley radius.

$$\alpha = \frac{a}{r}$$

$$\text{From this: } \tau = I \frac{a}{r}$$

Therefore:

$$(mg - ma)r = I \frac{a}{r}$$

From this equation, following the general chart equation of $y = mx + c$, the gradient of the chart of $(mg - ma)r$ against a/r will give a good average value for I of the flywheel, based on actual results.

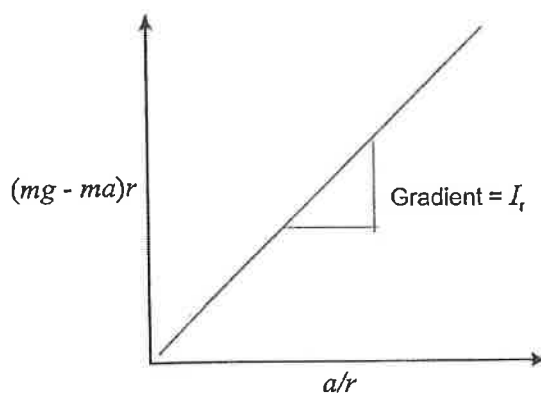


Figure 19 Chart to find Moment of Inertia