

# **EXAMINATIONS 2018 / 2019**

## **ARHOLIADAU 2018 / 2019**

**FACULTY OF:** Architecture, Computing & Engineering

**NAME OF COURSE/PROGRAMME:** HND/BSc Engineering Programmes

**YEAR OR LEVEL:** Level 4

**NAME OF MODULE/UNIT/EXAM PAPER:** Engineering Science 1

**MODULE NO:** M4X02192

**DATE OF EXAMINATION:**

**EXAMINATION TIMES:**

**START TIME:**

**FINISH TIME:**

**TIME ALLOWED:** 2 hours

### **INSTRUCTIONS TO CANDIDATES:**

Answer **all** questions.

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

Give answers to 2.d.p.

You are allowed a scientific calculator and a dictionary.

1.

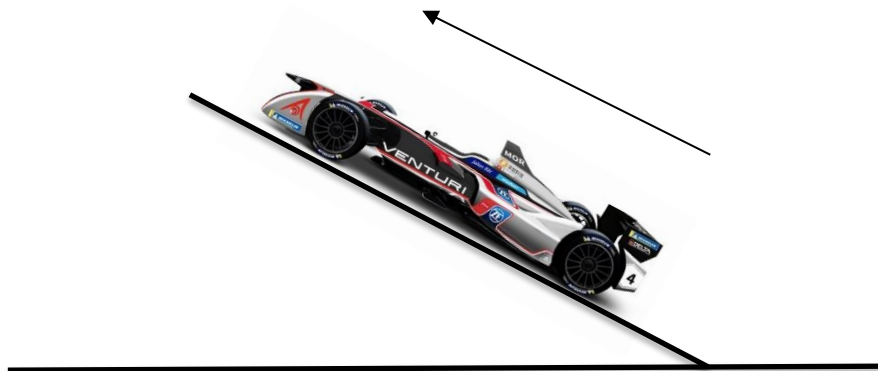
A formula e car performs a straight-line acceleration from 0 to 100km/h in 3 seconds. It then accelerates up to its top velocity of 225km/h in 10 seconds, when the brakes are immediately applied and it comes back to rest in 65m. Construct a velocity time graph [5 marks] and calculate:

- The rate of acceleration from 0-100km/h. [6 marks]
- The rate of acceleration from 100km/h to 225km/h. [5 marks]
- The braking time. [4 marks]
- And total displacement of the car. [8 marks]



**Figure 1:** FIA Formula E car.

2.



$$P = Fv$$

$$F = \mu R$$

At one circuit the Formula E car has to travel up a incline of  $20^\circ$  at a velocity of 140km/h. Given that the car has a mass of 888kg and that it is using 150kW of power, construct a forces diagram [5 marks] and calculate the coefficient of friction between the tyres and the incline. [12 marks]

3.



Figure 2: Electric motor

$$I = mk^2$$

$$T = I\alpha$$

$$P = T\omega$$

$$KE = \frac{1}{2} I\omega^2$$

The rotor of the electric motor of a Formula E car, accelerates up to 20000rpm in 0.5 seconds, where it reaches its peak torque of 145Nm. Calculate:

- The mass moment of inertia of the rotor. [9 marks]
- The mass of the rotating parts. Given the rotor has a diameter of 260mm. [5 marks]
- The power developed at this rpm in kW. [3 marks]
- The maximum kinetic Energy of the rotating parts in kJ. [3 marks]

4.

Children use a playground swing similar to the one show in in figure 3.

Given that the maximum displacement of the swing from its rest point is 1750mm and that is has a frequency of 0.65Hz. Calculate:

- the angular velocity of the swing. [4 marks]
- the periodic time of the motion of the swing. [2 marks]

Given that the force exerted on the swing cannot exceed 10kN calculate the maximum mass that the swing can take. [4 marks]



Figure 3: Nest swing

$$n = \frac{\omega}{2\pi}$$

$$T = \frac{2\pi}{\omega}$$

$$F_{\max} = m\omega^2 A$$

## **EXAMINATIONS 2016 / 2017**

## **ARHOLIADAU 2016 / 2017**

**FACULTY OF:** Architecture, Computing & Engineering

**NAME OF COURSE/PROGRAMME:** HND/BSc Engineering Programmes

**YEAR OR LEVEL:** Level 4

**NAME OF MODULE/UNIT/EXAM PAPER:** Engineering Science

**MODULE NO:** M4X02192

**DATE OF EXAMINATION:**

**EXAMINATION TIMES:**

**START TIME:**

**FINISH TIME:**

**TIME ALLOWED:** 2 hours

### **INSTRUCTIONS TO CANDIDATES:**

Answer **all** questions.

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

Give answers to 2.d.p.

You are allowed a scientific calculator and a dictionary.

1.

A life boat like the one in Figure 1, on a calm day, can accelerate up to its top speed with a rate of  $1.16\text{m/s}^2$ . It can return to rest once the engines have shut off, with a deceleration of  $3.22\text{m/s}^2$ , the total movement taking just 15s.

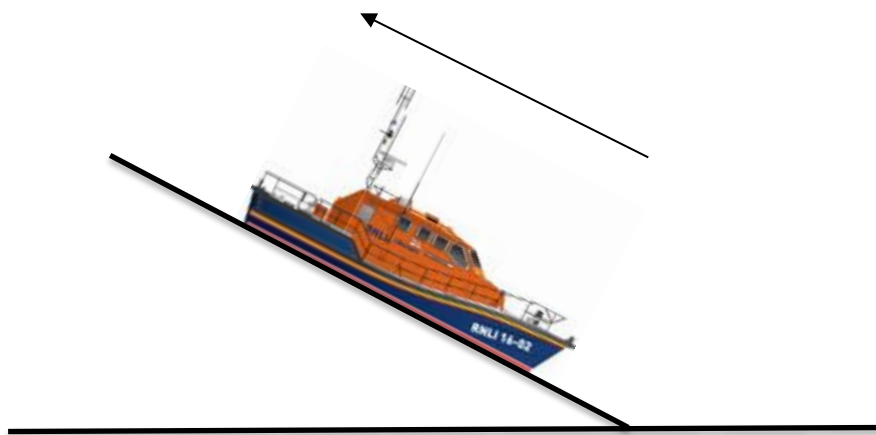
Construct a velocity time graph [3 marks] and calculate

- The maximum velocity of the boat. [12 marks]
- And the displacement of the boat in this time. [3 marks]



Figure 1: Life boat

2.



$$P = Fv$$

To haul the life boat back into its launch house, a 80kW winch is used. The launch ramp has a gradient of 1 in 4 measured along the slope. Given that the life boat weighs 32 tonnes and there is a constant friction resistance to motion between the ramp and the boat equivalent to 155N, construct a forces diagram [4 marks] and calculate the constant velocity the boat travels up the ramp. [9 marks]

3.



Figure 2

$$I = mk^2$$

$$T = I\alpha$$

$$P = T\omega$$

$$KE = \frac{1}{2} I\omega^2$$

The Life boat is powered by two Caterpillar C18 engines like the one in Figure 2. Given the rotating parts are considered to have a radius of gyration of  $k = 600\text{mm}$ , and the engine can achieve its maximum torque of  $4114\text{Nm}$  at  $1600\text{rpm}$  within 8 seconds of starting, Calculate:

- The mass moment of inertia of the rotating parts. [8 marks]
- The mass of the rotating parts. [4 marks]
- The power developed at this rpm in kW. [3 marks]
- The torque developed when the engine is at maximum power of  $746.5\text{kW}$ , which occurs at  $1800\text{rpm}$ . [4 marks]
- The maximum kinetic Energy of the rotating parts in MJ. [3 marks]

4.

A single cylinder engine as the piston assembly shown in Figure 3. It has a mass of  $0.25\text{kg}$  and can be considered to operate in simple harmonic motion. Given that the maximum acceleration and velocity experienced by the piston is  $15\text{m/s}^2$  and  $2\text{m/s}$  respectively calculate:

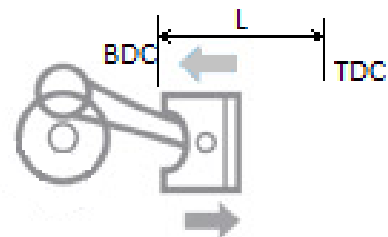


Figure 3.

- The stroke 'l', of the engine, [10 marks]
- The maximum force experienced by the system. [5 marks]
- The frequency of the motion. [2 marks]
- The periodic time of the motion. [2 marks]

$$a_{\max} = \omega^2 A$$

$$v_{\max} = \omega A$$

$$F_{\max} = m\omega^2 A$$

$$n = \frac{\omega}{2\pi}$$

$$T = \frac{1}{n}$$

## **EXAMINATIONS 2015 / 2016**

## **ARHOLIADAU 2015 / 2016**

**FACULTY OF:** Architecture, Computing & Engineering

**NAME OF COURSE/PROGRAMME:** HND/BSc Engineering Programmes

**YEAR OR LEVEL:** Level 4

**NAME OF MODULE/UNIT/EXAM PAPER:** Engineering Science  
Phase Test 1

**MODULE NO:** M1X9522

**DATE OF EXAMINATION:**

**EXAMINATION TIMES:**

**START TIME:**

**FINISH TIME:**

**TIME ALLOWED:** 2 hours

### **INSTRUCTIONS TO CANDIDATES:**

Answer **all** questions.

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

Give answers to 2.d.p.

Name:.....

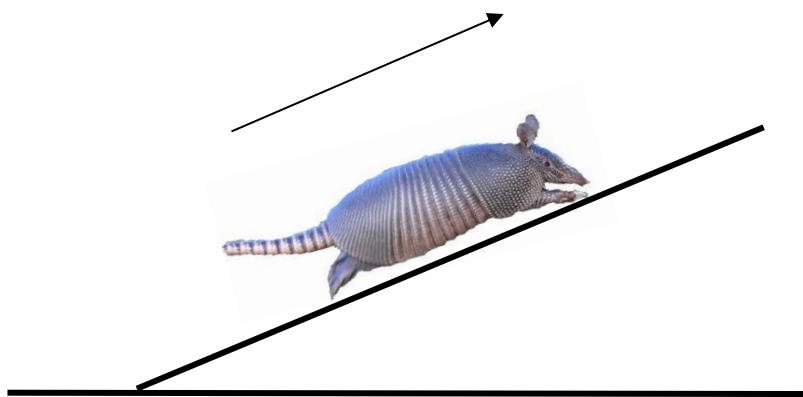
Programme:.....

1.

A lift departs from the top floor of a building and accelerates uniformly from rest, to its maximum speed 2m/s, in 25 seconds. It then decelerates and stops at the ground floor in 30 seconds. Sketch a velocity/time graph [3 marks] and calculate:

- a) The rate of acceleration of the lift, [4 marks]
- b) The rate of deceleration of the lift, [3 marks]
- c) The distance between the top and bottom floors of the buildings. [4 marks]

2.



$$P = Fv$$

$$F = \mu mg$$

Bertie the armadillo runs up a slope, measured 1 in 6 along the slope at a constant velocity of 1.5m/s. Given that Bertie has a mass of 5.75kg, and experiences a resistance to motion of 40N, construct a forces diagram [4 marks] and calculate the power he develops as he runs up the slope [7 marks].

Bertie reaches the top of the slope where the surface is level, what power would you need to push him along the level surface at a velocity of 0.5m/s given the coefficient of friction between Bertie and the floor is 0.2. [4 marks]

3.



$$k^2 = \frac{d^2}{8} \quad I = mk^2 \quad T = I\alpha \quad KE = \frac{1}{2} I\omega^2$$

Two children, each with a mass of 30kg, on a roundabout of diameter 1.8m, with a mass of 350kg, are accelerated from rest up to 30rpm in 4 seconds. They then come to rest against friction, in 2 minutes. Draw an angular velocity time graph [3 marks] and calculate:

- The angular acceleration of the roundabout, [5 marks]
- The total number of revolutions completed by the roundabout. [6 marks]
- The mass moment of inertia of the two children given they sit on the edge of the roundabout, [4 marks]
- The torque needed to get the roundabout and children up to the maximum velocity, [7 marks]
- The maximum kinetic energy of the children and roundabout. [4 marks]

4.



A rope climber of mass 70kg swings back and forth with simple harmonic motion, with an amplitude of 2m, and a frequency of 5Hz.

Calculate:

- The angular velocity of the rope climber, [6 marks]
- The period of the motion, [3 marks]
- The maximum acceleration at the extremities of the motion, [3 marks]
- The maximum force acting on the rope climber. [4 marks]

$$T = \frac{2\pi}{\omega} \quad N = \frac{\omega}{2\pi} \quad a = \omega^2 A \quad F_{\max} = m\omega^2 A$$

**EXAMINATIONS 2014 / 2015**  
**ARHOLIADAU 2014 / 2015**

**FACULTY OF:** Architecture, Computing & Engineering

**NAME OF COURSE/PROGRAMME:** HND/BSc Engineering Programmes

**YEAR OR LEVEL:** Level 4

**NAME OF MODULE/UNIT/EXAM PAPER:** Engineering Science  
Phase Test 1

**MODULE NO:** M1X9522

**DATE OF EXAMINATION:** Monday 26<sup>st</sup> January 2015

**EXAMINATION TIMES:**

**START TIME:** 11:00

**FINISH TIME:** 13:00

**TIME ALLOWED:** 2 hours

**INSTRUCTIONS TO CANDIDATES:**

Answer **all** questions.

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

Give answers to 2.d.p.

1.



Figure 1

The Hoonicorn in Figure 1 performs a linear drag test where it accelerates from rest up to 120km/h in 6.5s. It is immediately brought back to rest in 50m. It then accelerates up to 220km/h in 22s and is brought back to rest in 100m. Draw a velocity time graph on the axis provided below [3 marks] and calculate:

- The total time taken for the test. [12 Marks]
- The total distance travelled in the test.[10 Marks]
- The both of the rates of deceleration. [6 Marks]

2.

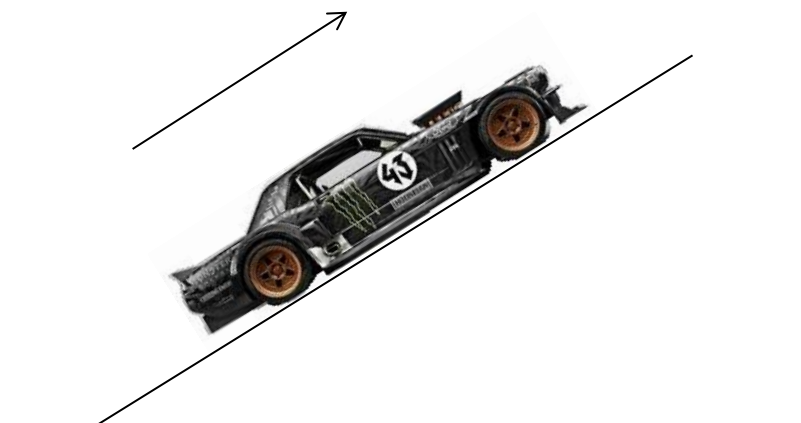


Figure 2.

Figure 2 above shows the Hoonicorn of mas 1375kg driving up an incline measuring 1 in 3.5 measured along the slope at 220km/h. Given that there is a constant resistance to motion of the order of 1550N construct a forces diagram on Figure 2 and calculate the power of the Hoonicorn.

[16 marks]

When travelling on a level surface at 220km/h with the wheels at the point of spinning, the Hoonicorn only needs 250kW, calculate the coefficient of friction between the tyres and the surface.

[6 marks]

$$P = F.v$$

$$F = \mu R_n = \mu mg$$

3.

A factory contains a flywheel similar to that in Figure 3, which has a mass of 8000kg. Given a torque of 4.2kNm the flywheel can accelerate up to 300rpm from rest in 45s. Calculate the radius and the kinetic energy of the flywheel. [18 marks]



Figure 3

$$T = I\alpha \quad I = mk^2 \quad k^2 = \frac{d^2}{8}$$

$$KE = \frac{1}{2} I\omega^2$$

4.

The piston assembly in Figure 4 has a mass of 0.35kg and can be considered to operate in simple harmonic motion, with a frequency, 'n', of 12Hz. Given that the stroke 'l', is 150mm calculate:

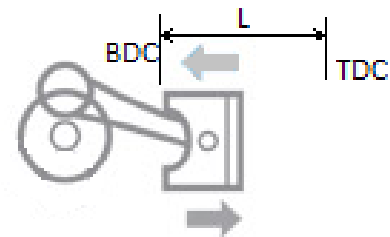


Figure 4.

- e. The periodic time of the motion. [4 marks]
- f. The angular velocity of the motion. [3 marks]
- g. The maximum acceleration of the motion [3 marks]
- h. The maximum force experienced by the system. [3 marks]

$$T = \frac{1}{n} \quad n = \frac{\omega}{2\pi} \quad a_{\max} = \omega^2 A \quad F_{\max} = m\omega^2 A$$



Faculty of Applied Design and Engineering

School of Automotive Engineering

HND Motorsport/ Automotive/ Motorcycle Engineering

Year 1

Engineering Science

Test 1

Monday 3<sup>rd</sup> February 2013

11 am

Instructions to candidates:

**There are three questions in this paper, answer all questions.**

**Give all answers to 2.d.p.**

Name:.....

1.



A Jaguar XC75 car has a mass of 1350kg. The car can accelerate uniformly from rest up to 100km/h in 3.4 seconds, from 100km/h to 160km/h in 2.1 seconds and finally from 160km/h to 300km/h in 10.2 seconds. Draw a velocity time graph [4 marks] and calculate:

- a. The acceleration up to 100km/h. [5 marks]
- b. The total distance covered. [18 marks]
- c. The maximum kinetic energy of the XC75. [3 marks]

The XC75 micro turbine motor develops 1600Nm of torque and generates the equivalent of 140kW of power.

- d. The angular velocity of the turbine. [4 marks]

Given that the rotating parts of the turbine can be accelerated from rest to this speed in 3.4 seconds, and that they have a radius of gyration of 0.25m calculate

- e. The mass of the rotating parts. [12 marks]
- f. The rotary energy of the system. [3 marks]

$$KE = \frac{1}{2}mv^2 \quad P = T\omega \quad T = I\alpha \quad I = mk^2 \quad KE = \frac{1}{2}I\omega^2$$

2.

a. The Jaguar of mass 1350kg and power 580kW is driven on a level road at its maximum velocity of 300km/h, calculate the co efficient of friction between the road and car tyres. [7 marks]

b. The car is now driven up Constitution Hill at a constant speed, given that the hill is inclined at 1 in 5 measured along the slope, and that the frictional force between the tyres and the road is 550N, construct a basic forces diagram [3 marks] and calculate the velocity. [13 marks]

$$P = Fv$$

$$F = \mu R = \mu mg$$

3. An internal combustion engine's valve train is accelerated from rest to 6500rpm in 0.05s, given that a single valve has a mass of 25g, calculate:

a. The angular acceleration the valve experiences, [5 marks]

b. The number of revolutions turned through in this time. [5 marks]

Given that once the valve had reached its operating speed of 6500rpm it can be considered to move with simple harmonic motion with amplitude of 25mm, calculate:

c. The frequency of motion, [3 marks]

d. The periodic time of motion, [3 marks]

e. The maximum force experienced by the valve. [5 marks]

f. The displacement from the equilibrium position given the linear velocity at this point is 13.6m/s. [7 marks]

$$n = \frac{\omega}{2\pi} \quad T = \frac{2\pi}{\omega} \quad F_{\max} = m\omega^2 A \quad v = \omega\sqrt{(A^2 - x^2)} \quad F = m\omega^2 x$$



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PRIFYSGOL FETROPOLITAN ABERTAWE

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Faculty of Applied Design and Engineering

School of Automotive Engineering

HND/BSc Motorsport/ Automotive/ Motorcycle Engineering

Year 1

Engineering Science

Test 1

Monday 3<sup>th</sup> February 2014

11am

Instructions to candidates:

There are three questions in this paper, answer all questions.

Name:.....

1.

A Citroen DS3 WRC car and occupants of have a combined mass of 1360kg. The car can accelerate uniformly from rest up to 96.6km/h in 3 seconds. The DS3 maintains this speed for 15 seconds, when the brakes are then applied and the car comes to rest in 8 seconds. Draw a velocity time graph and calculate:

- g. The distance travelled while accelerating. [7 marks]
- h. The maximum acceleration. [4 marks]
- i. The total distance covered. [4 marks]
- j. The maximum kinetic energy of the DS3. [4 marks]

The DS3 generates 223.7kW of power. Calculate:

- k. The force needed to accelerate the car up to 96.6km/h. [4 marks]
- l. The work done in accelerating the DS3 to its maximum velocity. [3 marks]

$$KE = \frac{1}{2}mv^2 \quad P = F.v \quad W.D = F.s$$

2.

The Citroen DS3 develops 350Nm of torque at 3250rpm. Given that the rotating parts of the engine can be accelerated from rest to this speed in 3 seconds, and that they have a radius of gyration of 0.9m, Calculate:

- a. The angular acceleration. [5 marks]
- b. The number of whole revolutions turned through in the acceleration. [4 marks]
- c. The moment of inertia of the crank shaft. [4 marks]
- d. The mass of the rotating components. [4 marks]
- e. The kinetic energy of the system. [4 marks]

$$T = I\alpha \quad I = mk^2 \quad KE = \frac{1}{2}I\omega^2$$

Given that the crank shaft moves a piston and connecting rod assembly of mass 3.81 kg with simple harmonic motion through a stroke of 0.05m, calculate:

- f. The periodic time of the motion, [3 marks]
- g. The maximum acceleration, [4 marks]
- h. The maximum force on the assembly. [4 marks]

$$T = \frac{2\pi}{\omega} \quad a_{\max} = \omega^2 A \quad F_{\max} = m\omega^2 A$$

3.

Abi now drives the Citroen of mass 1265kg up Mount Pleasant hill at a constant speed of 96.6km/h, given that the hill is inclined at 1 in 4 measured along the slope, and that there is a constant frictional resistance of 100N to the motion, construct a basic forces diagram [3 marks] and calculate the power needed from the engine [8 marks]. What is the angle of the slope in degrees? [2 marks].

The car then travels along a level surface with the wheels locked at 5km/h, calculate the coefficient of friction between the car and the surface if the power needed is 5kW. [7 marks]

$$P = Fv$$

$$F = \mu R = \mu mg$$



SWANSEA METROPOLITAN UNIVERSITY  
PRIFYSGOL FETROPOLITAN ABERTAWE

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Faculty of Applied Design and Engineering

School of Automotive Engineering

HND Motorsport/ Automotive/ Motorcycle Engineering

Year 1

Engineering Science

Test 1

Tuesday 4<sup>th</sup> September 2012

2 pm

Instructions to candidates:

There are three questions in this paper, answer all questions.

Name:.....

1.

A motorcycle stunt bike and rider have a combined mass of 250kg. They accelerate uniformly from rest travelling 400m in 25 seconds. The brakes are then applied and the bike comes to rest in 10 seconds. Draw a velocity time graph and calculate:

- m. The maximum velocity of the bike. [4 marks]
- n. The maximum acceleration. [4 marks]
- o. The distance covered while decelerating. [4 marks]
- p. The kinetic energy of the bike. [3 marks]
- q. The force needed to accelerate the bike. [3 marks]
- r. The work done in accelerating the bike to its maximum velocity. [3 marks]

The stunt bike then jumps from a platform 2.5m high to another 5.25m high, calculate the change in potential energy of the bike and rider. [6 marks]

$$KE = \frac{1}{2}mv^2$$

$$F = ma$$

$$W.D = F.s$$

$$PE = mgh$$

2.

A crank shaft of mass 2kg is accelerated uniformly from rest to a maximum angular velocity of 3000rpm in 10 seconds. The crank shaft has a radius of gyration of 0.05m. Calculate:

- i. The maximum angular velocity in rad/s. [1 mark]
- j. The angular acceleration. [4 marks]
- k. The number of whole revolutions turned through in the acceleration. [5 marks]
- l. The moment of inertia of the crank shaft. [3 marks]
- m. The kinetic energy of the system. [3 marks]
- n. Given that the crank shaft web's have a radius of 0.08m calculate the linear velocity and acceleration of a point on the tip of these webs. [6 marks]

$$I = mk^2$$

$$KE = \frac{1}{2}I\omega^2$$

$$v = r\omega$$

$$a = r\alpha$$

Given that the crank shaft moves a piston and connecting rod assembly of mass 0.35kg with simple harmonic motion through a stroke of 0.05m, calculate:

- o. The periodic time of the motion, [3 marks]
- p. The maximum acceleration, [3 marks]
- q. The maximum force on the assembly. [3 marks]

$$T = \frac{2\pi}{\omega}$$

$$a_{\max} = \omega^2 A$$

$$F_{\max} = m\omega^2 A$$

3.

Abi makes 5 students pull her car of 1250kg up Mount Pleasant hill at a speed of 1.5m/s, given that the hill is inclined at 1 in 5 measured along the slope, and that there is a constant frictional resistance of 150N to the motion, construct a basic forces diagram [3 marks] and calculate the power generated by the students [7 marks]. How much power does one student generate? [2 marks] What is the angle of the slope in degrees? [2 marks].

The car is then pulled along a level surface with the wheels locked by just 3 students at the same speed. Given the power of each student remains unchanged, calculate the coefficient of friction between the car and the surface. [7 marks]

$$P = Fv$$

$$F = \mu R = \mu mg$$



SWANSEA METROPOLITAN UNIVERSITY  
PRIFYSGOL FETROPOLITAN ABERTAWE

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Faculty of Applied Design and Engineering

School of Automotive Engineering

HND Automotive/Motorsport Engineering

Engineering Science

Phase Test 1

Monday 25<sup>th</sup> January 2010

Instructions to candidates:

There are four questions in this paper, answer all questions.

Where necessary take  $g = 9.81\text{m/s}^2$ .

Name:.....

Course:.....

1.

A rotating shaft and flywheel have a total moment of inertia of  $5\text{kgm}^2$  and rotate at 3000rpm. If the frictional resistance of the engine is the equivalent to a torque of 2Nm and that value is constant over all speeds, find:

- a) The kinetic energy of the system [4 marks],
- b) The power of the system [4 marks],
- c) The number of revolutions the engine will turn before it comes to rest when the fuel is cut [10 marks].

$$KE = \frac{1}{2} I \omega^2 \qquad P = T \omega \qquad T = I \alpha$$

2.

A motorcycle and rider of mass 225kg are travelling up a hill at constant velocity of 10 m/s. The hill is inclined at 1 in 4 measured along the slope and there is a constant frictional resistance of 55N acting against the motion of the motorcycle. Calculate:

- a) The power developed at the wheels of the motorcycle [10 marks],
- b) The power developed at the engine of the motorcycle if the losses to the transmission are 20% [4 marks],
- c) The angle of the slope in degrees [2 marks].

$$P = Fv$$

3.

A vehicle of mass 900kg is pulled from rest along a level surface with the wheels locked up to a constant velocity of 2.5m/s in period of 15s. The friction acting against the motion is equivalent to 175N. Calculate:

- a) The work done against the force [6 marks],
- b) The coefficient of friction between the vehicle and the level surface [8 marks].

$$WD = Fd \qquad F = \mu R$$

4.

The rotating parts of an engine may be considered to have a mass of 4.5kg acting at a radius of gyration of 0.15m. The mass of the engine as a whole is 85kg and it is propelling a vehicle at 45 km/h whilst rotating at a speed of 2500rev/min.

Determine:

- a) The kinetic energy of the rotating parts. [8 marks]
- b) The kinetic energy of the engine. [4 mark]
- c) The kinetic energy of the whole system. [2 mark]

This engine is then lifted from the vehicle; where it was mounted 0.3m above the ground to 1m for maintenance, calculate:

- d) The change in potential energy of the engine. [4 marks]