



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 4

LEFEL 4

EXAMINATION PERIOD

August 2020

CYFNOD ARHOLIADAU

AWST 2020

MODULE CODE: M4X00385
Engineering Science 1

TIME: 2 HOURS

ANSWER ALL QUESTIONS

Equipment or materials required – Scientific Calculator

Adnoddau neu ddefnyddiau sydd eu hangen - Cyfrifiannell Wyddonol

REMEMBER:

Take Gravity as 9.81m/s^2

Give all answers to 2.d.p unless otherwise instructed.

1.

In a crash simulation a vehicle is uniformly accelerated from rest at 5.5m/s^2 until it impacts with a wall. On impact with the wall it can be assumed to be brought back to rest with a uniform deceleration of 250m/s^2 . Given that the whole process takes 10 seconds draw a velocity time graph [3 marks] and calculate the velocity of the vehicle at impact with the wall in km/h, and the total distance travelled in this time. [16 marks]

2.

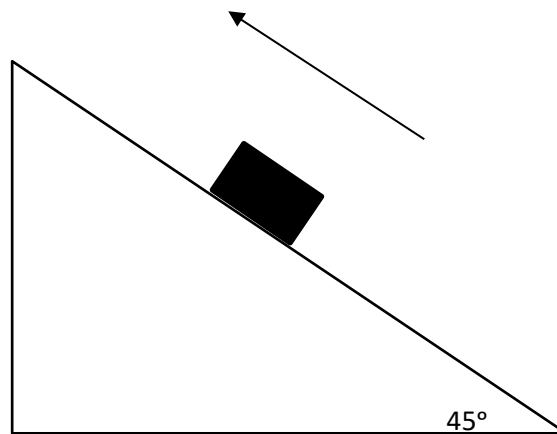


Figure 1

Whilst building the pyramids the Egyptians would haul building blocks with a mass of 1000kg up the side of the pyramid inclined at 45° from the horizontal (Figure 1).

Given that the average man can produce 120W of power, and each block has a coefficient of friction of 0.16, construct a basic forces diagram [5 marks] and calculate the least number of men needed to pull the block up one step at a velocity of 0.1m/s.

[10 marks]

When moving the block along a level surface the men are replaced by horses, each developing a power of 800W. Calculate the fewest number of horses needed to pull the block at a velocity of 2m/s assuming the friction remains unchanged. [6 marks]

$$P = Fv \qquad F = \mu R = \mu mg$$

3.

A Kinetic Energy Recovery System on a race car operates by making use of energy stored in a rotating flywheel. The car is charged by using an electric motor to get the flywheel up to its top speed of 3000rpm. One such flywheel is a homogeneous cylinder with a mass of 15kg and a radius of gyration of 0.15m.

a) What is the kinetic energy of the flywheel after charging? [5 marks]

b) If the car operates with an average power requirement of 6.5kW, how long does it take to charge?

[13 marks]

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

$$I = mk^2$$

$$T = I\alpha$$

$$P = T\omega$$

4.

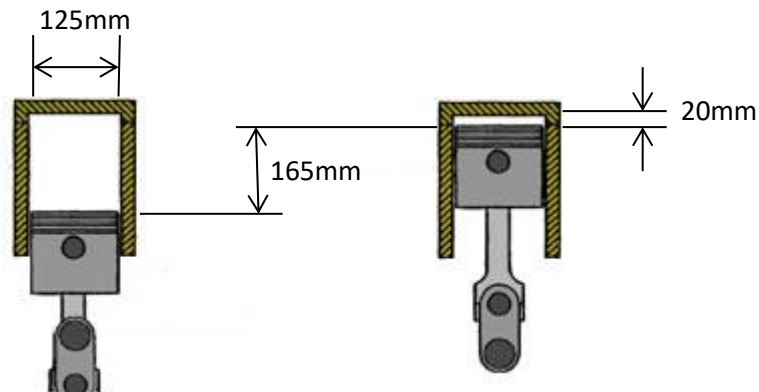


Figure 3

The large single cylinder engine has dimensions of those shown in Figure 2. At the commencement of the compression stroke the pressure is 1.008bar. Given that the pressure has increased to 35.5bar at a temperature of 550°C, calculate the temperature before combustion. [14 marks]

5.

A venturi meter is used to measure the flow of oil, of density 885kg/m³ in a horizontal pipe of 50mm diameter. If the throat of the meter is 25mm in diameter, what will the flow rate of the oil be if the pressure difference between the manometers is 3.5kPa? Assume there are no frictional losses.

[12 marks]

$$H = \frac{(p_1 - p_2)}{\rho g} = \frac{(v_2^2 - v_1^2)}{2g}$$

$$Q = A_1 \sqrt{\frac{(2gH)}{[(A_1 / A_2)^2 - 1]}}$$

6.

A concrete cooling tower or chimney in a factory works through convection. The cooling tower can be modelled as a hollow cylinder with a diameter of 5m and a height of 8m. The convective heat transfer coefficient is 12W/m²K. Calculate the heat transfer in kW from the tower, given the internal and external temperatures are 68°C and 15 °C respectively. [5 marks]

$$Q = hA((T_2 - T_1))$$

7.

An experimental section of solid steel bar with diameter 50mm, is simply supported at each end and undergoes a bending test. When loaded the bar is observed to have a radius of curvature of 1650m. Given that the steel chassis has a Young's modulus of elasticity of 95GN/m², calculate the maximum stress and the bending moment experienced by the beam. [14 marks]

$$I = \frac{\pi D^4}{64} \qquad \frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

8.

A solid cross section drive shaft has a diameter of 60mm. It is to be subjected to a torque of 580Nm and has a Modulus of rigidity of 110GN/m². Given that the shaft is 600mm long calculate the maximum shear stress and the angle of twist in degrees. [17 marks]

$$J = \frac{\pi D^4}{32} \qquad \frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$$

END OF TEST