



# **EXAMINATIONS 2011/2012      Semester 2**

## **ARHOLIADAU 2011/2012**

**FACULTY OF: APPLIED DESIGN & ENGINEERING**

**NAME OF COURSE/PROGRAMME:** BEng Manufacturing Systems Engineering  
BEng Motorsport Manufacturing Engineering

**YEAR OR LEVEL:** Year 2

**NAME OF MODULE/UNIT/EXAM PAPER:** Stress Analysis & Dynamics - RESIT

**MODULE NO:** M2X7195

**DATE OF EXAMINATION:** 31/1/12

**EXAMINATION TIMES:**

**START TIME:** 2 pm

**FINISH TIME:** 4 pm

**TIME ALLOWED:** 2 hours

### **INSTRUCTIONS TO CANDIDATES:**

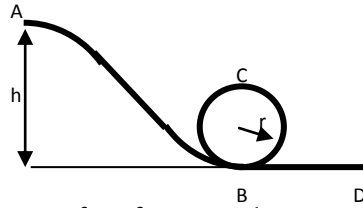
Answer 3 from 4 questions

Assume  $g = 9.81\text{ms}^{-2}$  in all calculations

Make sure you attach any graph paper to your answer booklet

### Question 1

a) A roller coaster, shown below, consists of a sloping section AB, a circular loop-the-loop section BC of radius  $r$ , and a straight horizontal section BD;



- i) By considering the transfer of energy, determine the least height, in terms of  $r$ , of A above B, from which the car can start from rest without falling off of the track at C.

[5 marks]

- ii) Briefly discuss the assumptions that you have made in your answer to part (i)

[2 marks]

b) A pile of mass 725kg can just support a stationary mass of 30,000kg without subsidence. The mass is removed and the pile is driven to a greater depth by blows of a 1500kg hammer dropping onto the top of the pile from a height of 1.3m. The hammer does not rebound from the top of the pile. Calculate;

- i) The penetration per blow assuming constant ground resistance

[8 marks]

- ii) The energy lost per blow.

[2 marks]

- iii) The efficiency of the operation.

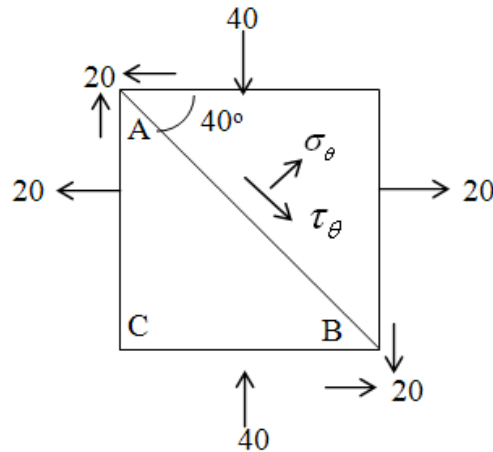
[1 mark]

- iv) Briefly discuss where the energy in part ii) is transferred and how realistic any assumptions you have made in your calculations are.

[2 marks]

## Question 2

- a. Consider the stressed element shown below. Determine what the normal and shear stresses on plane AB are using analytical methods.



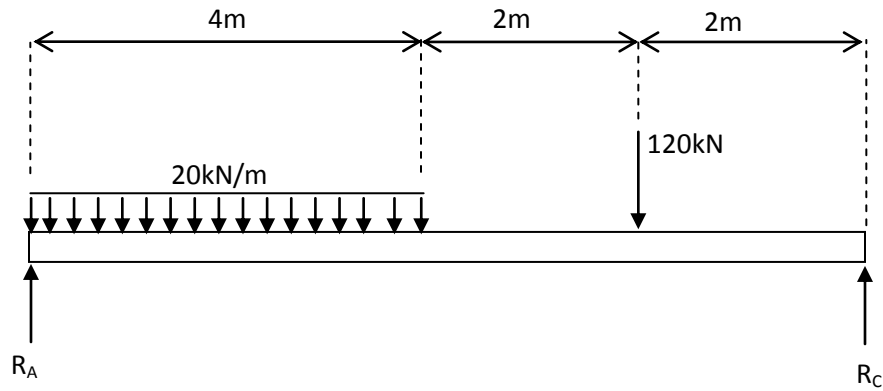
All  
stresses  
are in  
 $\text{MN/m}^2$

[5 Marks]

- b. What is the maximum principal stress on the above element?  
[2 Marks]
- c. What is the maximum shear stress on the above element?  
[2 Marks]
- d. Confirm your answers to a-c above using graphical methods on the graph paper attached to this exam paper. Make sure to mark clearly on the diagram any measurements that you take.  
[8 Marks]
- e. Using graphical methods, at what angle when measured anti-clockwise from plane BC is the maximum principal plane ?  
[2 Marks]
- f. Comment on the results from a-c when compared to those obtained in d.  
[1 Marks]

(Make sure you attach any graph paper to your answer booklet)

Question 3



A simply supported beam is loaded as shown above. Show that;

a. The slope at A is given by:  $\frac{dy}{dx} = -\frac{540}{EI}$

[14 Marks]

b. The slope at C is given by:  $\frac{dy}{dx} = \frac{606.6}{EI}$

[3 Marks]

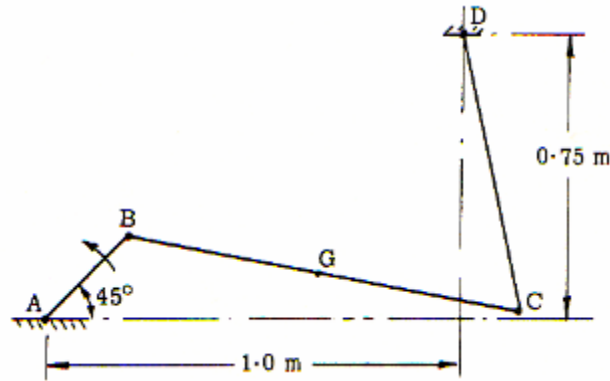
c. The deflection at B is given by:  $y = \frac{-1413.3}{EI}$

[3 Marks]

Question 4

- a. Attached to this exam paper is a 'line diagram' of the below mechanism, which has been drawn to scale. The diagram shows a mechanism in which the crank AB rotates anticlockwise about A at 70 rev/min. The link CD swings about D and is connected to the crankpin B by the link BC. The lengths are; AB, 0.25m, BC, 1.0m, CD, 0.75m. Draw the velocity diagram and hence find the velocity of C relative to D.

[10 marks]

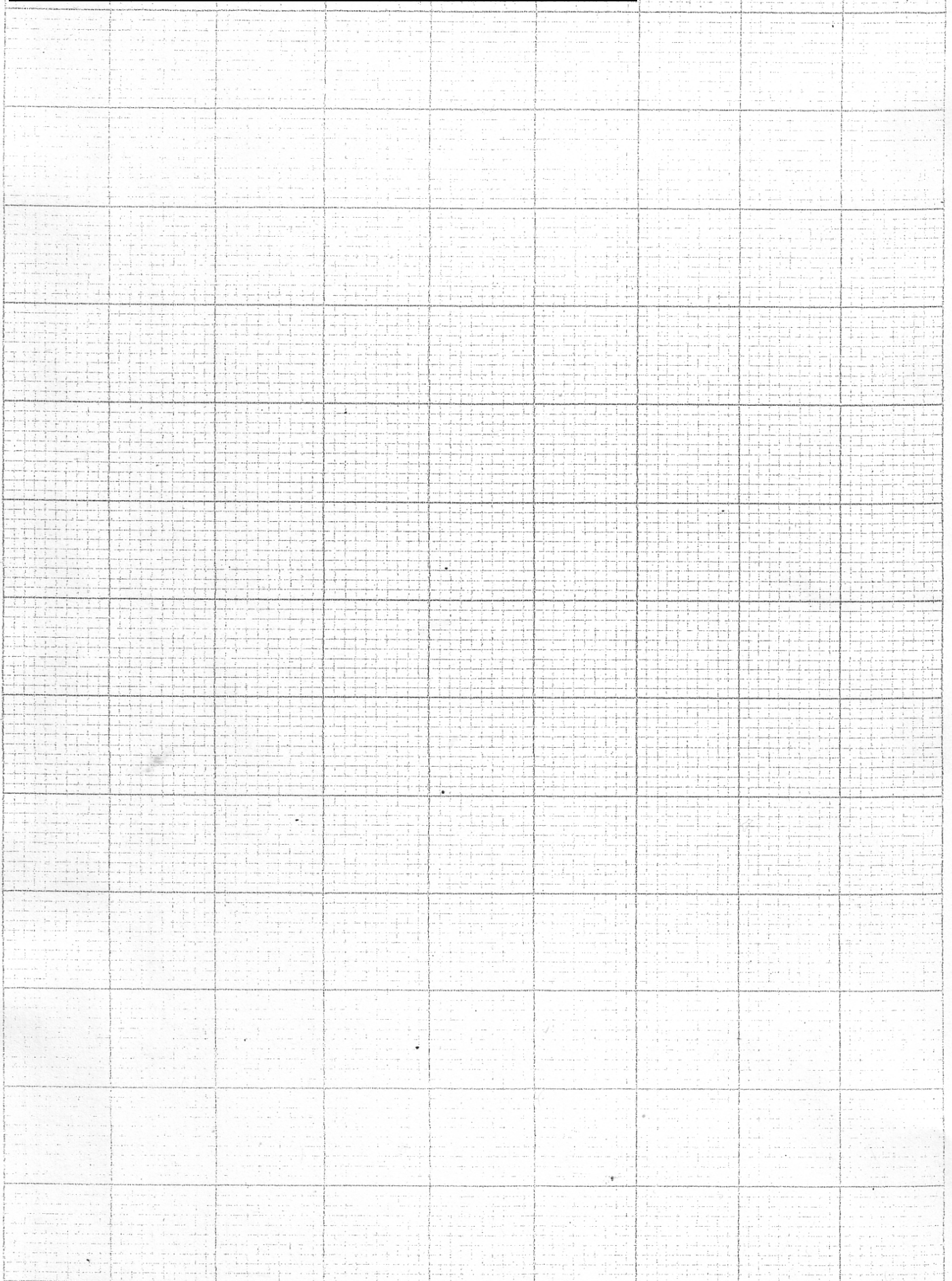


- b. Using the velocity diagram from part a, draw the acceleration diagram and hence find the resultant acceleration of B relative to C.

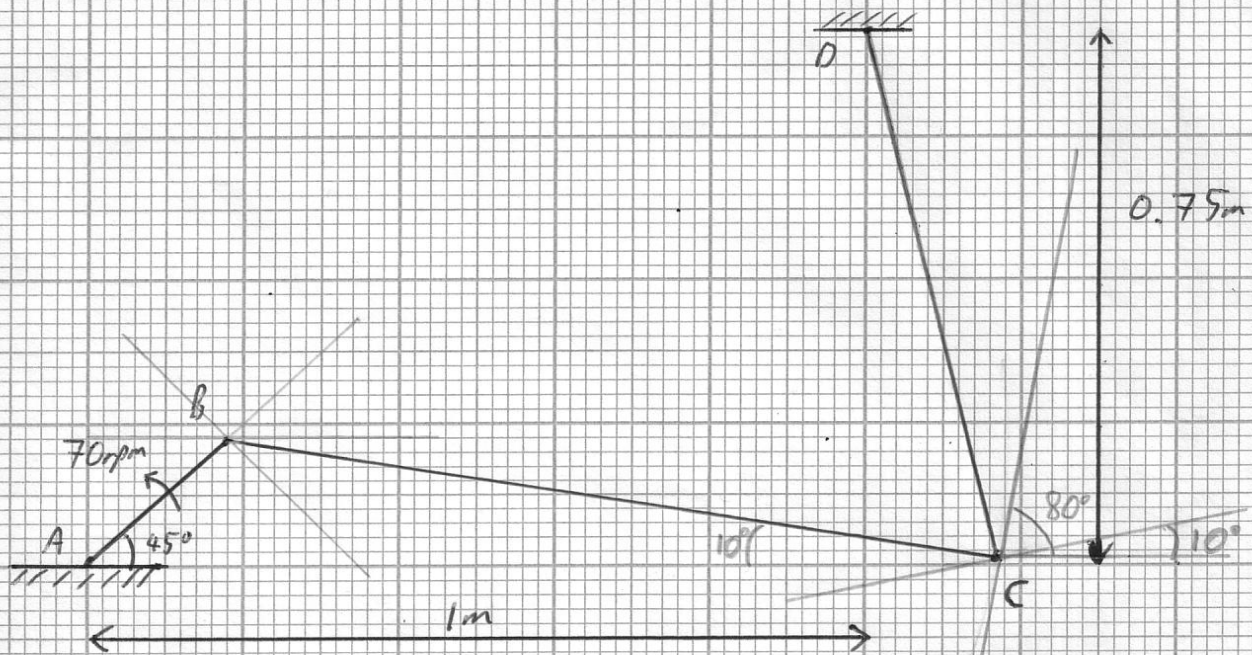
[10 Marks]

(Make sure you attach any graph paper to your answer booklet)

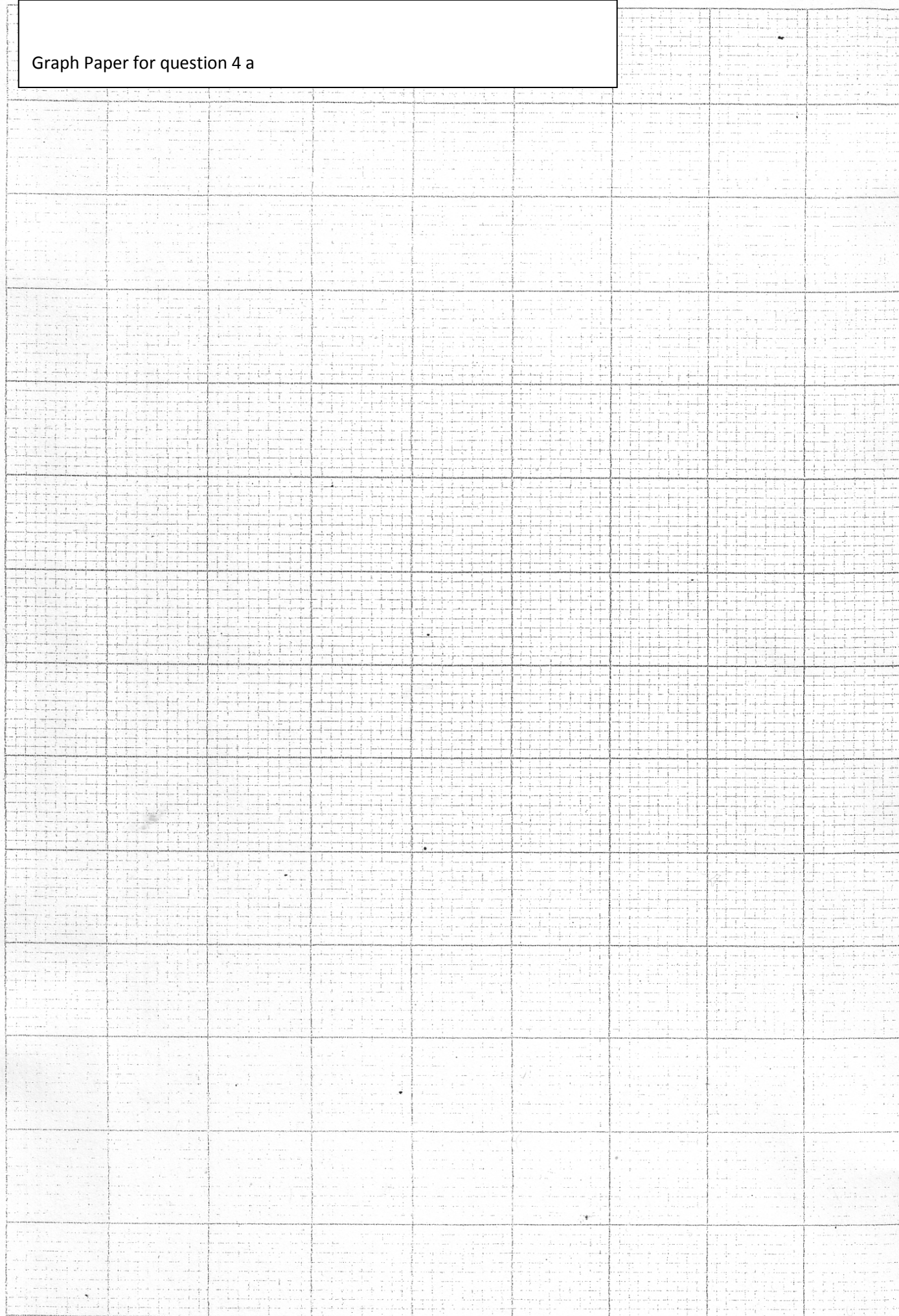
Graph Paper for question 2 d



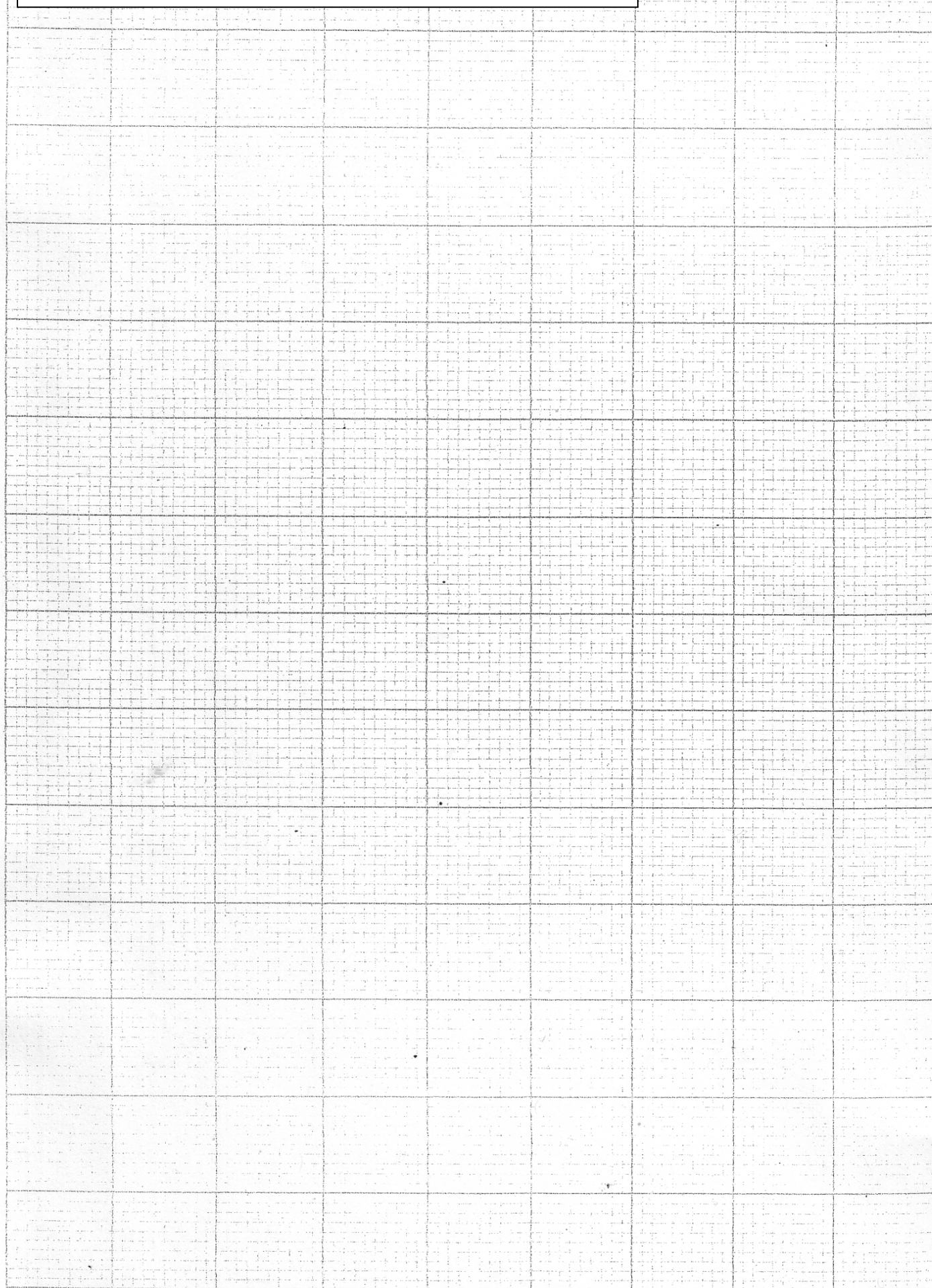
Line diagram for question 4 a



Graph Paper for question 4 a



Graph Paper for question 4 b



# Formula Sheet

Assume  $g = 9.81\text{ms}^{-2}$  in all calculations

## Dynamics

$$\text{Centripetal Force} = \frac{mv^2}{r}$$

Linear acceleration

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$\text{Potential Energy} = mgh$$

$$\text{Kinetic energy} = \frac{1}{2}mv^2$$

$$\text{Momentum} = \text{Mass} \times \text{Velocity}$$

## Complex Stress

$$\sigma_{\theta} = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y)\cos 2\theta + \tau_{xy} \sin 2\theta$$

$$\tau_{\theta} = \frac{1}{2}(\sigma_x - \sigma_y)\sin 2\theta - \tau_{xy} \cos 2\theta$$

$$\sigma_{1,2} = \frac{1}{2}\left[(\sigma_x + \sigma_y) \pm \sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}\right]$$

$$\tau_{\max} = \frac{1}{2}\sqrt{(\sigma_x - \sigma_y)^2 + 4\tau_{xy}^2}$$

## Slope and deflection of beam theory;

$$EI \frac{d^2y}{dx^2} = M \quad \text{Bending moment.}$$

$$Q = EI \frac{d^3y}{dx^3} \quad \text{Shear Force}$$

$$w = EI \frac{d^4y}{dx^4} \quad \text{Load}$$