ACCRA INSTITUTE OF TECHNOLOGY

The University of the Future

END OF TRIMESTER EXAMINATIONS

JANUARY 2022 TRIMESTER

DATE: MAY 2022

COURSE CODE: ENG 102 / PHYS 101

COURSE TITLE: ENGINEERING SCIENCE

LECTURER'S NAME: MR NAPOLEON ADDISON

	COURSE OUTLINE (MAIN TOPICS)	QUESTION NO.
MajorTopic-1	Vectors	1a,
MajorTopic-2	Projectile Motion	1b, 2c
MajorTopic-3	Momentum	1c,
MajorTopic-4	Circular Motion	2a,
MajorTopic-5	Kinematics	2b,4c,
MajorTopic-6	Dynamics	3a,4b,
MajorTopic-7	Matter and Materials	3b,
MajorTopic-8	Forces	3c, 4a,
MajorTopic-9	Moment	5a,
MajorTopic-10	Dimensional Analysis	5b,
MajorTopic-11	Motion Graphs	5c
MajorTopic-12	Work, Energy and Power	6a
MajorTopic-13	Newtons Laws	6b
MajorTopic-14	Hooke's Law	6c
MajorTopic-15	Electricity	5c
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PART A

FOUR QUESTIONS ANSWER THREE

Question 1

a) Vector 'a' has magnitude 5.0m and is directed east. Vector 'b' has magnitude 4.0m and is directed 35^0 west of north. What are (a) the magnitude and (b) the direction of 'a + b'?

Major Topic	Blooms Designation	Score
Vectors	NA	7

b) Prove that, the range, R the time of flight, T and the Maximum height, H by a projectile are respectively given by;

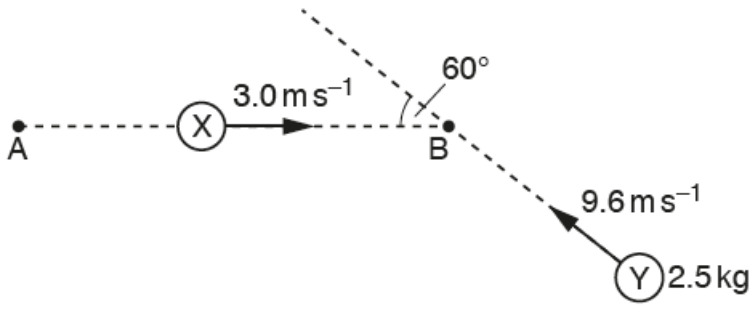
$$R = \left({v_o^2}/{g}\right) sin2\theta \quad , \quad T = {(2v_o sin\theta)}/{g}$$

$$H = \frac{V_0^2 \ sin^2 \theta}{2g}$$

Major Topic	Blooms Designation	Score
Projectile Motion	AP	7

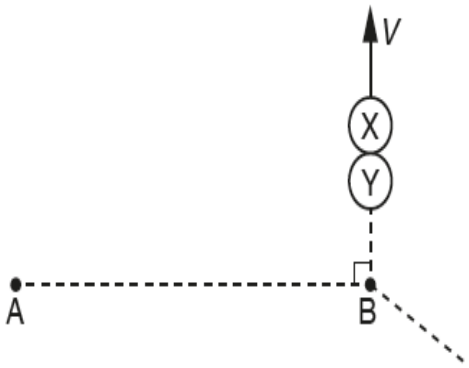
c)

Two balls, X and Y, move along a horizontal frictionless surface, as illustrated in Fig. 3.1.



Ball X has an initial velocity of $3.0\,m\,s^{-1}$ in a direction along line AB. Ball Y has a mass of 2.5 kg and an initial velocity of $9.6\,m\,s^{-1}$ in a direction at an angle of 60° to line AB.

The two balls collide at point B. The balls stick together and then travel along the horizontal surface in a direction at right-angles to the line AB, as shown in Fig. 3.2.



By considering the components of momentum in the direction from A to B, show that ball X has a mass of 4.0 kg.

Major Topic	Blooms Designation	Score
Momentum	EV	6

TOTAL SCORE: 20

Question 2

a) Will a body moving in a circular track have zero acceleration? Vividly explain your making reference to both radial and perpendicular acceleration?

Major Topic	Blooms Designation	Score
Circular Motion	AN	8

b) An electron moving along the x axis has a position given by x = (16te−t) m, where t is in seconds. How far is the electron from the origin when it momentarily stops?

Major Topic	Blooms Designation	Score
Kinematics	**EV**	**6**

c) Explain why the vertical component of the velocity (Vy) of a projectile motion is zero at the maximum height but the Horizontal Component of the velocity (Vx) is constant thorough out the parabolic motion?

Major Topic	Blooms Designation	Score
Projectile Motion	AN	6

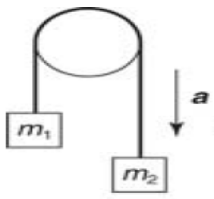
TOTAL SCORE: 20

Question 3

a) Consider the pulley below where m2 > m1. Show that the acceleration and tension
in the string are

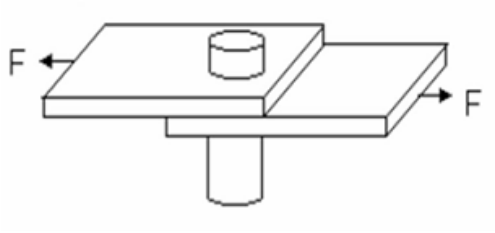
$$a = \frac{m_2 - m_1}{m_2 + m_1} g$$

$$T = \frac{2 m_2 m_1}{m_2 + m_1} g$$



Major Topic	Blooms Designation	Score
Dynamics	AP	7

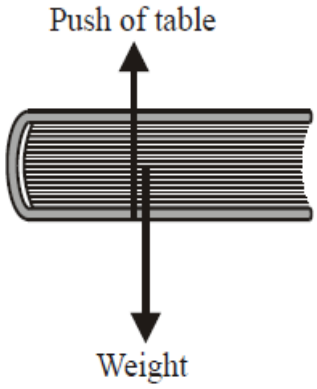
b) Two strips of metal are pinned together as shown, with a rod of 10mm diameter. The Ultimate shear stress for the rod is 60MPa. Determine the maximum force required to break the pin.



Major Topic	Blooms Designation	Score
Matter and Materials	AP	6

c)

A book is resting on a table. A student draws a correct free-body force diagram for the book as shown below.



The student makes the incorrect statement that "The forces labelled above make a Newton third law pair; therefore the book is in equilibrium". Criticise this statement.

Major Topic	Blooms Designation	Score
Forces		7

TOTAL SCORE: 20

Question 4

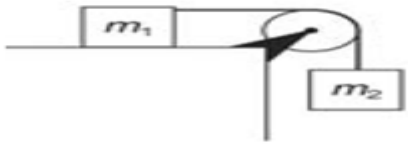
a) A cement bag and a sheet of paper are all dropped from the 4th floor of the AIT building without the influence of air resistance. Which one gets to the

ground first. Explain your answer

Major Topic	Blooms Designation	Score
Forces	AN	7

b) Consider an object sitting on a frictionless surface and another object hangs off the edge of the table over a pulley. Make a free-body diagram and show that

$$a = \frac{m_2}{m_2 + m_1} g \text{ and } T = \frac{m_2 m_1}{m_2 + m_1} g \text{ respectively.}$$



Major Topic	Blooms Designation	Score
Dynamics	AP	7

c) State Newton's first and second laws of motion.

Major Topic	Blooms Designation	Score
Kinematics	EV	6

TOTAL SCORE: 20

PART B

TWO QUESTIONS ANSWER ALL

Question 5

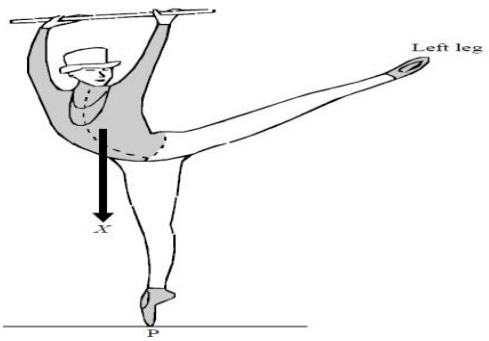
a) In quantum mechanics, the fundamental constant called Planck's constant, h, has dimensions of. Construct a quantity with the dimensions of length from h, a mass m, and c, the speed of light

Major Topic	Blooms Designation	Score
Dimensional Analysis	UN	8

b)

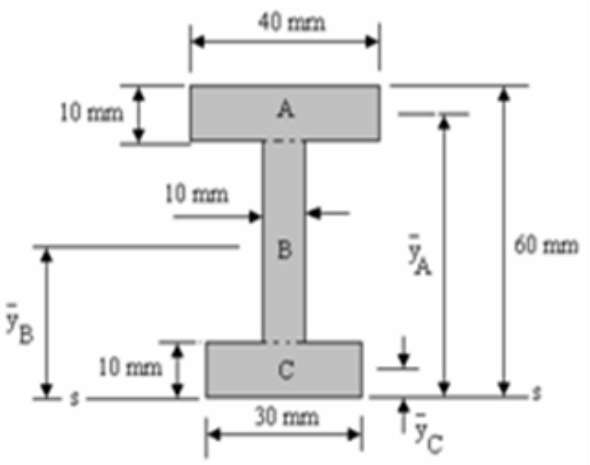
The diagram shows a ballet dancer balancing on the point P of her right foot, with her left leg extended.

With reference to the relative sizes and positions of these forces, explain how this situation illustrates the principle of moments. You may be awarded a mark for the clarity of your answer.



Major Topic	Blooms Designation	Score
Moment	AP	6

c) Calculate the first moment of area for the shape shown below about the axis s – s and find the position of the centroid.



Major Topic	Blooms Designation	Score
Moment	AP	6

TOTAL SCORE: 20

Question 6

a) You are on an island and you have two coconuts. The coconuts are launched with the same initial speed. The trajectory of coconut A is such that the coconut goes very high, but falls not much farther from the spot it was launched. The trajectory of coconut B is such that coconut B goes not as high as coconut A, but falls much farther from the spot it was launched. Explain with the idea of projectile motion which coconut hits the ground first.

Major Topic	Blooms Designation	Score
Projectile Motion	EV	6

(b) A block X of mass m_X slides in a straight line along a horizontal frictionless surface, as shown in Fig. 3.1.

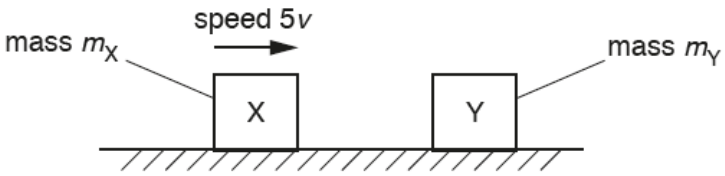


Fig. 3.1

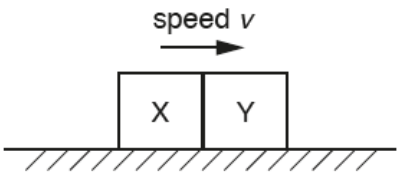


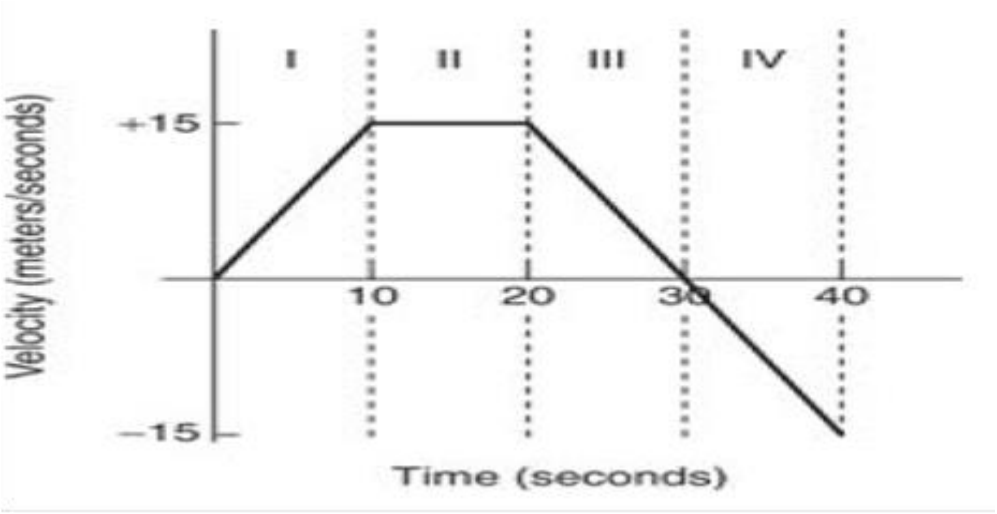
Fig. 3.2

The block X, moving with speed $5v$, collides head-on with a stationary block Y of mass m_Y. The two blocks stick together and then move with common speed v, as shown in Fig. 3.2.

(i) Use conservation of momentum to show that the ratio $\frac{m_Y}{m_x}$ is equal to 4.

Major Topic	Blooms Designation	Score
Momentum	AP	6

b) Explain the situation in each of the segments, I, II, III and IV.



Major Topic	Blooms Designation	Score
Motion Graphs	AN	8

TOTAL SCORE: 20