# IS COM INCOMINATION OF THE OF ASSESSMENT F.Y.C.P. HARIESENALS.COM F.Y.C.P. MARAN

### Question 1 (\*\*)

A particle of mass 2 kg is travelling with velocity  $(2\mathbf{i}-3\mathbf{j})$  ms<sup>-1</sup> when it receives an impulse of  $(4\mathbf{i} + A\mathbf{j})$  Ns, where A is a constant. The velocity of the particle after it receives the impulse, is  $(B\mathbf{i}+8\mathbf{j})$  ms<sup>-1</sup>.

Find the value of A and the value of B.



### Question 2 (\*\*)

A cricket ball of mass 0.25 kg is travelling with velocity 15 i ms<sup>-1</sup> when it is struck by a bat. The ball receives an impulse of (-5i+8j) Ns. The cricket ball is modelled as a particle and air resistance is ignored.

- a) Determine the speed of the cricket ball after the impact.
- b) Calculate the angle that the velocity of the cricket ball after impact makes with the vector **i**.
- c) Find the kinetic energy gain of the cricket ball, as a result of the impact.

| $v \approx 32.4 \text{ ms}^{-1}$  | , 98.9°, 103 J  |
|---|---|
| P   | 1912  |
| (3) $\begin{split} \vec{L} &= my - my \\ -S_{1} + 8_{2} &= \frac{1}{4}x - \frac{1}{4}(S_{1}) \\ -2S_{1} + 82_{3} &= x - S_{1} \\ -S_{1} + 32_{3} &= x - S_{1} \\ -S_{1} + 32_{3} &= x \\ \cdot &  \chi  = \sqrt{(S_{1}^{2} + 32^{2})^{2}} \\ \approx 32.4 \text{ ma}^{3} \\ \text{(b)} \\ T \\ \text{(b)} \\ T \\ \text{(b)} \\ T \\ \text{(c)} $ | $B_{0}^{2}$ $(1) = \frac{1}{2} \sum_{i=1}^{N} \frac{1}{i} \sum_{i=1}^{N} \frac{1}{i$ |

### Question 3 (\*\*)

A particle of mass 0.5 kg is moving in a straight line on a smooth horizontal surface.

The particle is acted on by a horizontal force of magnitude (4t-9) N, where t represents the time, in seconds, measured from a certain instant.

At time t = 1, the particle has speed 6 ms<sup>-1</sup>

Find the value of t when the particle has a speed of  $18 \text{ ms}^{-1}$ .



60 N

### Question 4 (\*\*)

A cricket ball, of mass 0.15 kg reaches a batsman with horizontal velocity of  $15 \text{ ms}^{-1}$ . It is struck in such a way so that it leaves the bat with a horizontal velocity of  $25 \text{ ms}^{-1}$ .

If the bat and the ball are in contact for 0.1 s, determine the average force exerted by the bat on the ball.

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### Question 5 (\*\*+)

A particle of mass 2 kg is moving on a smooth horizontal plane with speed 1.4 ms<sup>-1</sup> when it receives an impulse of magnitude *I* Ns, in a direction perpendicular to its direction of motion.

The speed of the particle after it receives I changes to 5 ms<sup>-1</sup>

Determine the value of I

### Question 6 (\*\*+)

An ice hockey player of mass 75kg after being tackled by another hockey player is heading with constant speed of  $6 \text{ ms}^{-1}$  towards the vertical cushioned wall, in the perimeter of the ice rink.

The cushioning exerts a force F N, acting in a direction perpendicular to wall and its magnitude is given by

 $F = 6 \times 10^4 t^2 (1 - 2t), \ 0 \le t \le 0.5.$ 

The player remains in contact with the cushioning for 0.5 s

Determine the speed of the hockey player after he rebounds off the cushioned wall.

 $\frac{1}{2} \approx 2.33 \text{ ms}^{-1}$ 

I = 9.6

 $\begin{aligned} & \mathbf{F}_{\text{ENTLY}} & \mathbf{L}_{\text{e}} = \int_{-t_{\text{e}}}^{t_{\text{e}}} \mathbf{F}(\mathbf{d}, dt) = \int_{-s}^{s} (\mathbf{f}_{\text{e}}(\mathbf{x}) \mathbf{d}^{t}) \mathbf{t}^{2}(\mathbf{j} - \mathbf{z}t) dt \\ & = \int_{-s}^{s} (\mathbf{f}_{\text{e}}(\mathbf{x}) \mathbf{d}^{t}) \mathbf{t}^{2}(\mathbf{j} - \mathbf{z}t) \mathbf{d}^{t} = \int_{-s}^{s} (\mathbf{f}_{\text{e}}(\mathbf{z}) \mathbf{d}^{t}) \mathbf{d}^{t} \\ & = \int_{-s}^{s} (\mathbf{f}_{\text{e}}(\mathbf{z}) \mathbf{d}^{t}) \mathbf{d}^{t} \mathbf{d}^$ 

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- 625 = 75V (-75X6
- $V = \frac{7}{3}$
- V 12 2:33 MS

### Question 7 (\*\*+)

A particle of mass 5 kg is moving in a straight line on a smooth horizontal surface under the action of a single force F which varies with time t as

$$F(t) = (12 - 2t) \mathrm{N},$$

where t is measured in seconds since an arbitrary instant.

When t = 1 the particle has velocity 6 ms<sup>-1</sup>.

- a) Determine the velocity of the particle when t = 5.
- **b**) Find the value of t when the velocity of the particle is  $-9 \text{ ms}^{-1}$



 $v = 10.8 \text{ ms}^{-1}$ 

t = 16

### Question 8 (\*\*+)

A particle of mass m kg is moving in a straight line on a smooth horizontal surface under the action of a single force F which varies with time t as

 $F(t) = \left(5t^{\frac{3}{2}} - 2t\right) \mathbf{N},$ 

where t is measured in seconds since an arbitrary instant.

When t = 1 the particle has velocity  $-47 \text{ ms}^{-1}$ .

When t = 9 the particle has velocity 54 ms<sup>-1</sup>.

Determine the velocity of the particle when t = 4.



 $v = -35.25 \text{ ms}^{-35}$ 

### Question 9 (\*\*\*)

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A particle, of mass 0.5 kg moving with velocity of  $(4\mathbf{i}-2\mathbf{j})$  ms<sup>-1</sup> receives an impulse  $(k\mathbf{i}+2k\mathbf{j})$  Ns, where k is a constant.

 $k = \pm 2$ 

 $\int \frac{(2k+u)^2}{4} + \frac{(4k-2)^{2-1}}{4} = 10$   $\frac{(2u+u)^2}{4} + \frac{(4k-2)^2}{4} = 100$   $\frac{4k^2+(2k+1)k+10k^2-(2k+1)k+10k}{2k^2+20} = 100$   $\frac{2k^2+20}{4} + 200 = 100$   $\frac{2k^2+20}{4} = \frac{1}{4}$ 

After receiving the impulse the particle is moving with speed  $10 \text{ ms}^{-1}$ 

Determine the possible values of k.

## **Question 10** (\*\*\*)

In this question  $\mathbf{i}$  and  $\mathbf{j}$  are mutually perpendicular unit vectors.

A particle *P* of mass 0.5 kg is moving with velocity (i+3j) ms<sup>-1</sup> when it receives an impulse I Ns.

Immediately after I is applied, P has velocity (7i-5j) ms<sup>-1</sup>.

- **a**) Find the magnitude of the impulse.
- b) Calculate the angle between the direction of I and the direction of motion of *P* immediately is I applied.



|         | in the |       |
|---------|--------|-------|
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### **Question 11** (\*\*\*)

In this question  $\mathbf{i}$  and  $\mathbf{j}$  are mutually perpendicular unit vectors.

A small ball of mass 0.25 kg is moving on a smooth horizontal surface when it is struck by a bat. The bat exerts an impulse (-8i+4j) Ns on the ball.

Immediately after receiving the impulse the ball has velocity (12i + 20j) ms<sup>-1</sup>

- a) Find the speed of the ball immediately before the impact.
- **b**) Calculate the size of the angle through which the direction of motion of the ball is deflected by the impact.

, speed =  $\sqrt{1952} = 4\sqrt{122} \approx 44.2 \text{ ms}^{-1}$ ,  $\approx 53.8^{\circ}$ 



Question 12 (\*\*\*)

 $A - \frac{120^{\circ}}{24 \,\mathrm{ms}^{-1}} \frac{36 \,\mathrm{ms}^{-1}}{B}$ 

The figure above shows the plan of the path of a cricket ball of mass 0.25 kg, passing through the points A, B and C, which lie on the same horizontal plane.

The cricket ball is moving along AB with speed 24 ms<sup>-1</sup>. The cricket ball is being struck by a bat at *B* and immediately after the strike, the cricket ball is moving along *BC* with speed 36 ms<sup>-1</sup>. The angle *ABC* is 120°, as shown in the figure.

The cricket ball is modelled as a particle moving without any resistance, on the same horizontal level.

a) Find the magnitude of the impulse exerted by the bat onto the cricket ball.

**b**) Determine the acute angle the impulse makes with the line AB.

 $=3\sqrt{7}\approx 7.94$  Ns ≈ 79.1°

Question 13 (\*\*\*)



The points A, B and C, which lie on the same horizontal plane. A ball of mass 0.5 kg is travelling along AB with speed 40 ms<sup>-1</sup> when it receives an impulse I of magnitude 30 Ns, in the direction BC.

The angle ABC is  $90^{\circ} - \theta$ , as shown in the figure, where  $\tan \theta = \frac{4}{3}$ .

The ball is modelled as a particle moving without any resistance.

- a) Find the magnitude of the velocity of the ball, immediately after it receives I.
- b) Determine the acute angle the velocity of the ball makes with the direction AB, immediately after it receives I.

Myl<sup>t</sup>= 1myl+ 1Il<sup>2</sup>- 2[myl(I[cs(90.8) 20<sup>2</sup> + 30<sup>2</sup> - 2×20×30 1/4/2 = 400 + 900 - 1200x + < (Fr θ)i+(30005))] = 0:5<u>v</u> ... ±102 340 30 (0-18) à 4 W1= 13 42.0 1 = 100' ~ 319 WI / 1 31900 0.54 = ANR ↓ |= √(-e)<sup>2</sup>+ 36<sup>2</sup> = √1360 ~ 36.1mi  $\frac{Sn\psi}{|I|} = \frac{Sn(h)}{|I|}$ tost -2 1360 SMP + -976187. 14= 77.5 1 = 77.5° / A 3464

 $||\mathbf{v}| = 4\sqrt{85} \approx 36.9 \text{ ms}^{-1}$ 

≈77.5°

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 $52 \text{ ms}^{-1}$ 

Question 14 (\*\*\*+)

The figure above shows the plan of the path of a cricket ball of mass 0.25 kg, passing through the points A, B and C, which lie on the same horizontal plane.

В

28 ms<sup>-1</sup>

50

The cricket ball is moving along AB with speed 28 ms<sup>-1</sup>

The cricket ball is being struck by a bat at *B* and immediately after the strike, the cricket ball is moving along *BC* with speed  $52 \text{ ms}^{-1}$ .

As a result of the impact the path of the cricket ball is deflected by 50°, as shown in the figure.

The cricket ball is modelled as a particle moving without any resistance, on the same horizontal level.

- a) Find the magnitude of the impulse exerted by the bat onto the cricket ball.
- **b**) Determine the acute angle the impulse makes with the line AB.







A particle P of mass 0.5 kg is moving in a straight line with speed 4 ms<sup>-1</sup>.

An impulse of magnitude I Ns is applied to P, acting at an acute angle  $\theta$  to the direction of motion of P, as shown in the figure above.

After the impulse was applied, P is moving with speed 8 ms<sup>-1</sup> in a direction which is inclined by an acute angle  $\alpha$  to its original direction of motion.

Given that  $\sin \alpha = \frac{3}{5}$ , determine the value of *I* and the value of  $\theta$ .

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| $\frac{4}{4} = \frac{\sqrt{72}}{\sqrt{72}}$ $\Rightarrow Sm\theta = 0.844427$ | 19,)                    |           |        |   |

 $\frac{6}{5}\sqrt{5} \approx 2.68$ ,  $\theta = \arctan 2 \approx 63.4^{\circ}$ 

### Question 16 (\*\*\*+)

In this question  $\mathbf{i}$  and  $\mathbf{j}$  are mutually perpendicular unit vectors.

A particle of mass 0.5 kg is moving on a smooth horizontal plane with velocity  $14\mathbf{i} \text{ ms}^{-1}$  when it receives an impulse  $\lambda(\mathbf{i} + \mathbf{j})$  Ns, where  $\lambda$  is a positive constant.

Immediately after receiving the impulse the particle is moving with speed 34 ms<sup>-1</sup>, in a direction which makes an acute angle  $\alpha$  with the vector **i**.

a) Calculate the value of  $\alpha$ , correct to the nearest degree.

**b**) Determine the value of  $\lambda$ .





,  $\alpha \approx 28^{\circ}$  ,  $\lambda = 8$ 

man

# Question 17 (\*\*\*+)

A particle P of mass 8 kg is moving on a straight line under the action of a single force F which acts in the direction of motion of P.

At time t s , 
$$F = (3\sqrt{t} + 1)$$
 N,  $0 \le t \le 25$ 

When t = 0, the velocity of P is 1.2 ms<sup>-1</sup>.

When t = T, the velocity of P is 3.7 ms<sup>-1</sup>.

Determine the value of T

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Į.G.B.

|               | $ \begin{bmatrix} \mathbf{I} = \int_{t}^{t_2} F(t) dt \end{bmatrix} $ $ \begin{array}{l} mv - mu = \int_{t}^{t} 3dt + 1 dt \\ 8x37 - 8x12 = \int_{t}^{t} 3dt + 1 dt \\ \end{array} $ | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ | $\begin{array}{l} (\pounds\Gamma  \frac{1}{2}(\underline{x}) = 2\underline{x}^{3} + \underline{x}^{2} - \underline{z}_{0} \\  -\underline{x}_{1}(\cdot) = 2 + 1 - z_{0} \neq_{0} \\  -\underline{x}_{1}(\cdot) = -2 + 1 - \underline{z}_{0} \neq_{0} \\  \underline{x}_{1}(\cdot) = -2 + 1 - \underline{z}_{0} \neq_{0} \\  \underline{x}_{1}(\cdot) =  _{0} + \underline{x}_{0} - \underline{z}_{0} = o \\  \underline{x}^{*}  (\underline{x} - \underline{x})(\underline{x}^{*} + \underline{x}_{0} + t_{0}) = o \end{array}$ |
|---------------|--|---|---|
| )             | $2o = \left[2t\frac{1}{2} + t\right]_{o}^{T}$  | 5                                       | t<br>b <sup>2</sup> -4ac = 5 <sup>2</sup> -4x2×10 <0  |
| 3             | $\partial o = \left( \Im T^{\frac{8}{2}} + T \right)_{-0} o$   | 3                                       | ONLY SOLUTION 2 = 2   |
| $\rightarrow$ | $\partial T^{\frac{3}{2}} + T - 20 = 0$  | >                                       | T <sup>3</sup> =2   |
|               | $2\alpha_1^3 + \alpha_2^2 - 20 = 0$<br>where $\alpha = T_{2}^2$  | 3                                       | Ta 4  |

T = 4

·C.A

25 ms

Question 18 (\*\*\*\*)

20 Ns

The figure above shows the plan of the path of a ball of mass 0.2 kg, moving along AB with constant speed 25 ms<sup>-1</sup>.

At *B* the ball receives an impulse of magnitude 20 Ns in the direction *BC*, where  $\angle ABC = 70^\circ$ , as shown in the figure.

The points A, B and C, which lie on the same horizontal plane and the ball is modelled as a particle moving without any resistance, on the same horizontal level.

a) Find the speed of the ball after it receives the impulse.

**b**) Determine the acute angle the speed of the ball makes with the line *AB*, after it receives the impulse.





### Question 19 (\*\*\*\*+)

Two particles, A and B, of mass 5 kg and 2 kg respectively, are each attached to the ends of a light inextensible string of length 2a m. The particles are placed on a smooth horizontal surface so that |AB| = a m.

*B* is projected along the surface with speed  $12 \text{ ms}^{-1}$  in a direction perpendicular to the straight line joining the initial positions of *A* and *B*.

When the string becomes taut, ...

**a**) ... determine the magnitude of the impulsive tension in the string.

**b**) ... show that the system experiences a loss of  $77\frac{1}{7}$  N, in kinetic energy.

START WITH A DIAGRAM  $=\frac{a}{as} = \theta_{2}ab$ Solard FURSION ...

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|--|
| (THE VELOCITY OF & IS ONOHANGED IN THAT DIBECTION)   |
| $0 = 12 \text{ sm} 30 = .6 \text{ ms}^{-1}$  |
| SPEED OF B APTHO = $\sqrt{V^2 + u^2}$  |
| $=\sqrt{(\frac{12}{7}\sqrt{3})^2+6^2}=\sqrt{\frac{432}{49}+36}$  |
| $=\sqrt{\frac{2}{2}}$  |
| SPEED OF A 4PTIN = $V = \frac{12}{7}\sqrt{3}$  |
| LINETIC ENERGY BEFORE = 1 × 2×12 = 144J  |
| kinxtric finite for the for the form of the form o |
| $=\frac{1080}{49}+\frac{2196}{49}$   |
| $=\frac{468}{7}$   |
| Hence A loss of 144 - $\frac{468}{7} = \frac{540}{7} = 77\frac{1}{7}$  |
|  |

 $I = \frac{60}{7}\sqrt{3} \approx 14.85 \text{ Ns}$ 

### Question 20 (\*\*\*\*+)

Two particles, A and B, of mass 4 kg and 1 kg respectively, are each attached to the ends of a light inextensible string of length  $\sqrt{3}a$  m. The particles are placed on a smooth horizontal surface so that |AB| = a m.

A is projected along the surface with speed 20 ms<sup>-1</sup> in a direction which makes an angle of 60° with the straight line joining the initial positions of A and B, as shown in the figure below.



When the string becomes taut, determine the magnitude of the impulsive tension in the string and show further that the speed of B is  $4\sqrt{7}$  ms<sup>-1</sup>.



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