DPP – 4 (Work, Energy & Power)

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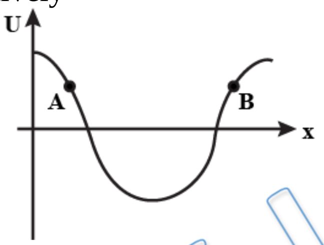
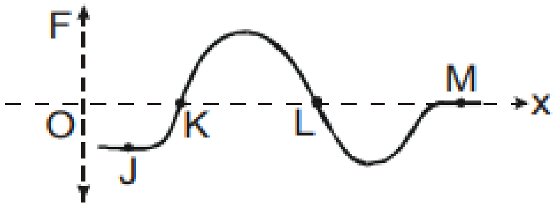
Q 1. Potential energy v/s position curve for one dimensional conservative field is shown. Force at A and B is respectively



(a) Positive, Positive
(b) Positive, Negative
(c) Negative, Positive
(d) Negative, Negative

Q 2. A particle is being acted upon by one dimensional conservative force. In the F–x curve shown, four points J, K, L, M are marked on the curve. State which type of equilibrium is the particle have at position L



(a) stable equilibrium
(b) unstable
(c) Neutral
(d) No equilibrium

Q 3. A particle located in one dimensional potential field has potential energy function $U(x) = \frac{a}{x^2} - \frac{b}{x^3}$, where a and b are positive constants. The position of equilibrium corresponds to x equal to

(a) $\frac{3a}{2b}$ (b) $\frac{2b}{3a}$
(c) $\frac{2a}{3b}$ (d) $\frac{3b}{2a}$

Q 4. In a conservative field at stable equilibrium potential energy is:
(a) Maximum (b) Minimum
(c) Constant (d) None of these

Q 5. The power of pump, which can pump 200 kg of water to a height of 50 m in 10 sec, will be ($g = 10\, m/s^2$)
(a) $10 \times 10^3\ watt$ (b) $20 \times 10^3\ watt$
(c) $4 \times 10^3\ watt$ (d) $60 \times 10^3\ watt$

Q 6. If the power of the motor of a water pump is 3 kW, then the volume of water in liters that can be lifted to a height of 10m in one minute by the pump is ($g = 10\, m/s^2$ and density of water = 1000 kg/m^3)
(a) 1800 (b) 180
(c) 18000 (d) 18

Q 7. If the heart pushes 1 cc of blood in one second under pressure 20000 N/m^2 the power of heart is
(a) 0.02 W (b) 400 W
(c) 50 W (d) 0.2 W

Q 8. The power of a heart which pumps $5 \times 10^3\ cc$ of blood per minute at a pressure of 120 mm of mercury ($g = 10\, m/s^2$ and density of Hg = $13.6 \times 10^3\ kg/m^3$) is
(a) 1.36 W (b) 13.6 W
(c) 0.136 W (d) 136 W

Q 9. A particle moves with a velocity $\vec{V} = (5\hat{\imath} - 3\hat{\jmath} + 6\hat{k})\ m/s$ under the influence of a constant force $\vec{F} = (10\hat{\imath} + 10\hat{\jmath} + 20\hat{k})N$, the instantaneous power applied to the particle is
(a) 200 W (b) 320 W
(c) 140 W (d) 170 W

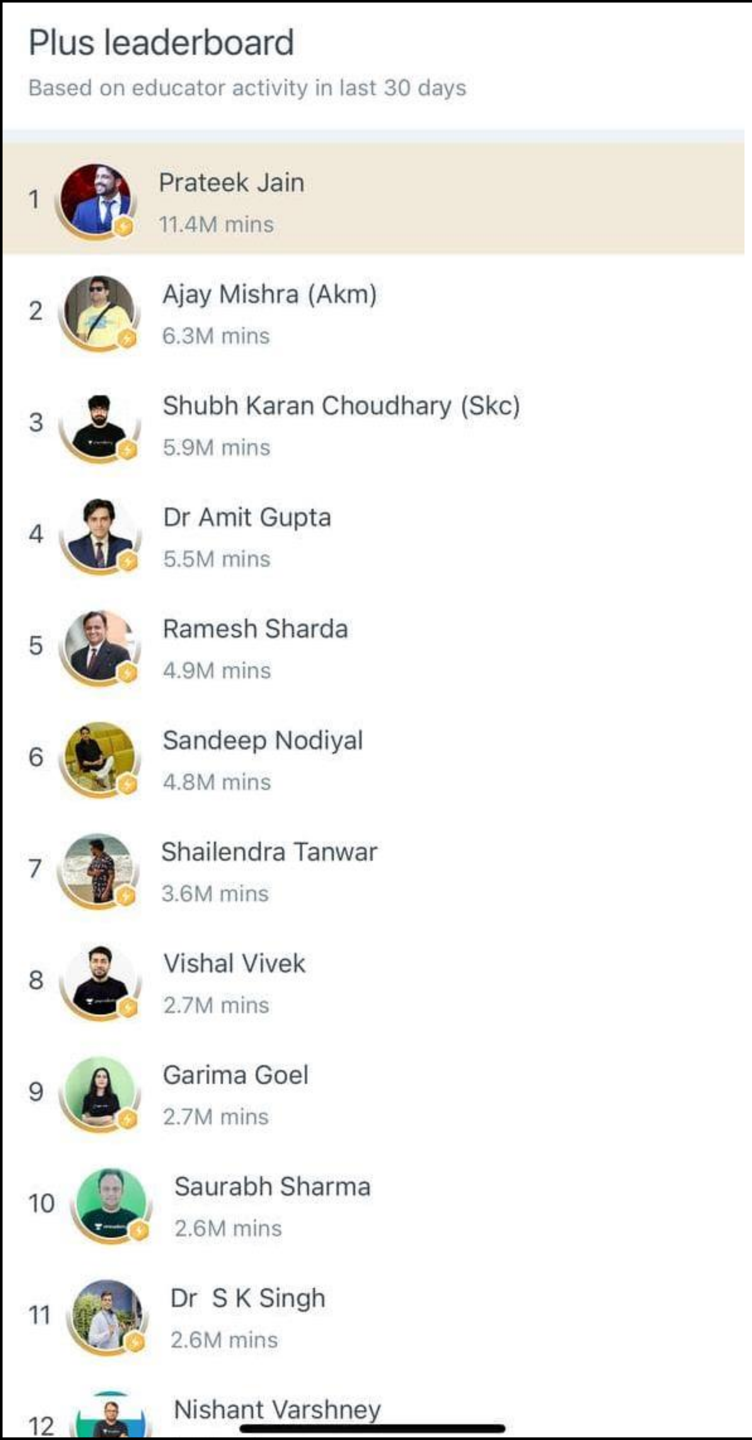
Q 10. A motor boat is travelling with a speed of 3.0 m/sec. If the force on it due to water flow is 500 N, the power of the boat is
(a) 150 KW (b) 15 KW
(c) 1.5 KW (d) 150 W

Q 11. An engine develops 10 kW of power. How much time will it take to lift a mass of 200 kg to a height of 40 m ($g = 10\, m/s^2$)
(a) 4 sec (b) 5 sec
(c) 8 sec (d) 10 sec

Q 12. A 10 H.P. motor pumps out water from a well of depth 20m and fills a water tank of volume 22380 liters at a height of 10m from the ground. the running time of the motor to fill the empty water tank is ($g = 10\, m/s^2$)
(a) 5 minutes (b) 10 minutes
(c) 15 minutes (d) 20 minutes

Answer Key

Q.1 b	**Q.2 a**	**Q.3 d**	**Q.4 b**	**Q.5 a**
Q.6 a	**Q.7 a**	**Q.8 a**	**Q.9 c**	**Q.10 c**
Q.11 c	**Q.12 c**			



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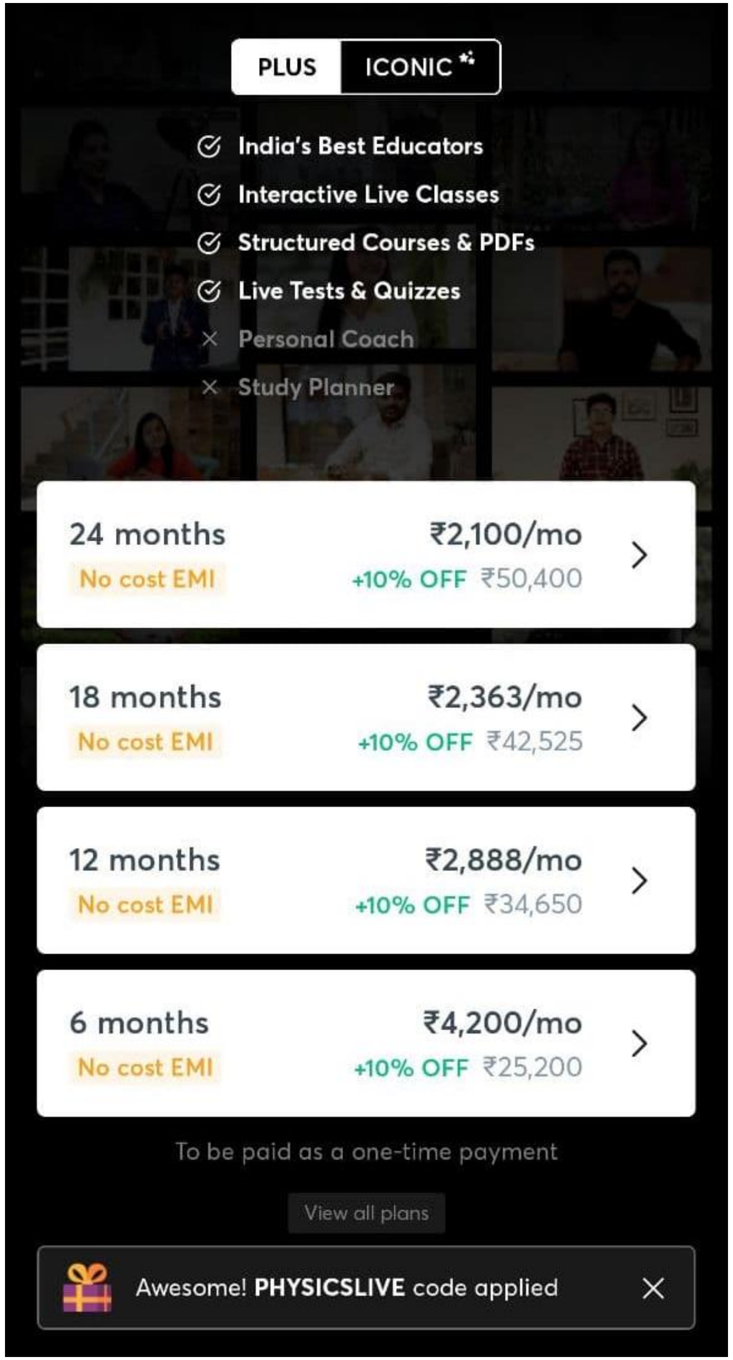

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Physics DPP

DPP-4 WEP: Equilibrium, Power

By Physicsaholics Team

Solution: 1

at point 'A'

$$\frac{dU}{dx} = -ve$$

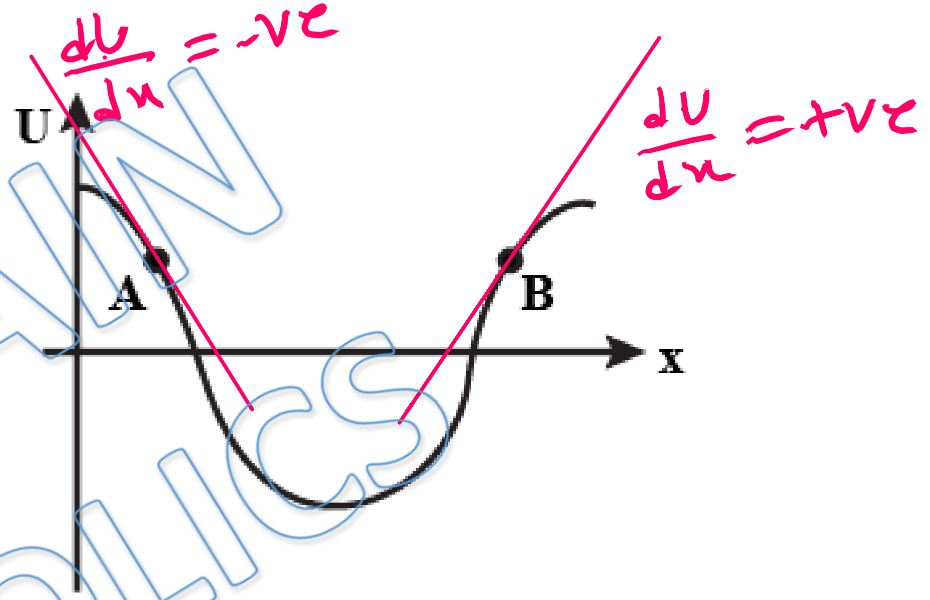
$$F_A = -\left(\frac{\partial U}{\partial x}\right)_A = +ve$$

at point 'B'

$$\frac{dU}{dx} = +ve$$

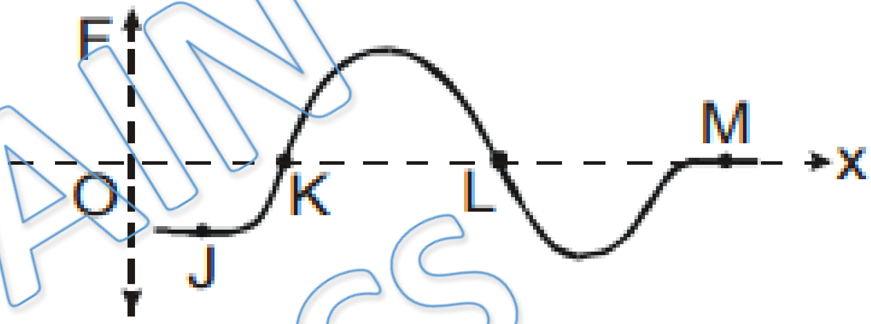
$$F_B = -\left(\frac{dU}{dx}\right)_B = -ve$$

So; $F_A = +ve$; $F_B = -ve$



Ans. b

Solution: 2



at point $x = L$

$F = 0$; Equilibrium.

when $x > L$

$F = -ve$ (towards L)

when $x < L$

$F = +ve$ (towards L)

$\therefore$ $x = L$ is stable Equilibrium.

Ans. a

Solution: 3

$$U = \frac{a}{x^2} - \frac{b}{x^3}$$

$$F = -\left(\frac{\partial U}{\partial x}\right) = -\left(-\frac{2a}{x^3} + \frac{3b}{x^4}\right) = 0$$

$$\frac{2a}{x^3} = \frac{3b}{x^4} \Rightarrow 2a = \frac{3b}{x} \Rightarrow \boxed{x = \frac{3b}{2a}}$$

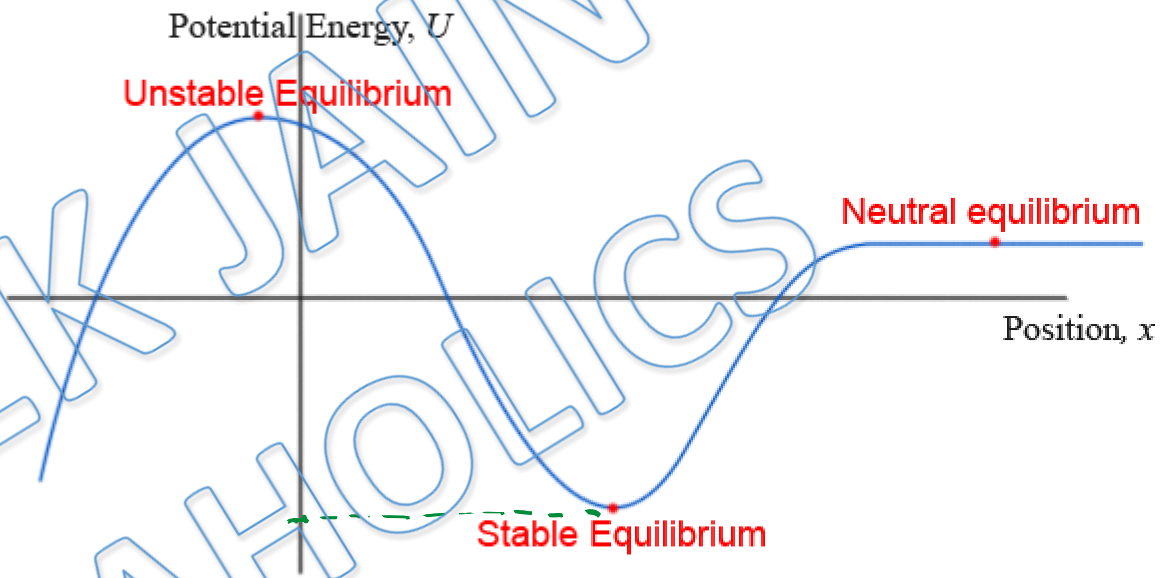
at $x = \frac{3b}{2a}$; $F = 0$

so; Equilibrium will be at $\boxed{x = \frac{3b}{2a}}$ Ans

Ans. d

Solution: 4

At Stable Equilibrium
"P.E. will be Minimum"



Ans. b

Solution: 5

$$P = \frac{W}{t} = \frac{mgh}{t}$$

$$P = \frac{200 \times 10 \times 50}{10}$$

$$\boxed{P = 10 \times 10^{3} \text{ watt}} \text{ Ans.}$$

Ans. a

Solution: 6

$V_1 \rightarrow$ Volume of water

$$P = \frac{mgh}{t} \Rightarrow 3\times10^3 = \frac{(\rho V_1)\times 10\times 10}{60}$$

[∵ 1 minute = 60 sec]

$$3\times10^3 = \frac{1000\times V_1 \times 100}{60}$$

$$\Rightarrow V_1 = \frac{180}{100} = 1.8\,m^3 = 1.8\times1000 \text{ Litre}$$

$$\boxed{V = 1800 \text{ Ltr}}$$ Ans.

Ans. a

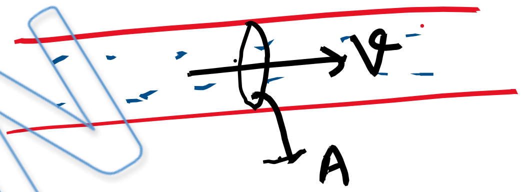
Solution: 7

Volume $= V = 1\,cc = 10^{-6}\ m^3$

time $= t = 1\ sec$

$P_r = 2\times10^4\ N/m^2$

v = speed of flow



Let; fluid applying force Force at any crossection 'A' & moving with speed 'v'

$$\text{Pressure} = \frac{F}{A} \Rightarrow \text{Pressure} \times v = \frac{F}{A} v$$

$$\Rightarrow \underbrace{Fv}_{\text{Power}} = \text{Pressure} \times \underbrace{v \times A}_{\text{Change in volume per sec}}$$

P = work done per Second

$= \text{Pressure} \times (\Delta V \text{ in } 1\ \text{Sec})$

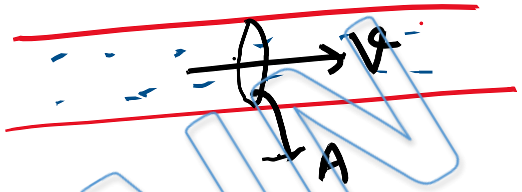
$= 20000 \times 1 \times 10^{-6}$

$= .02\ \text{Watt}$

Ans. a

Solution: 8

v = speed of flow



Let; fluid applying force Force at any crossection 'A' & moving with speed 'v'

$$\text{Pressure} = \frac{F}{A} \Rightarrow \text{Pressure} \times v = \frac{F}{A}v$$

$$\Rightarrow \underbrace{Fv}_{\text{Power}} = \text{Pressure} \times \underbrace{v \times A}_{\text{Change in volume per sec.}}$$

$$\text{Power} = \frac{\Delta W}{\Delta t} = \frac{P\,\Delta V}{\Delta t} = \frac{(120\times10^{-3} \times 10 \times 13.6\times10^{3})(5\times10^{3}\times10^{-6})}{60}$$

$$= 1.36 \text{ Watt}$$

Ans. a

Solution: 9

$$\vec{v} = 5\hat{i} - 3\hat{j} + 6\hat{k} \quad (m/s)$$

$$\vec{F} = 10\hat{i} + 10\hat{j} + 20\hat{k} \quad (N)$$

$$P = \vec{F}\cdot\vec{v} = (10\hat{i} + 10\hat{j} + 20\hat{k})\cdot(5\hat{i} - 3\hat{j} + 6\hat{k})$$

$$P = 50 - 30 + 120$$

$$\boxed{P = 140 \text{ watt}} \text{ Ans.}$$

Ans. c

Solution: 10

$P = FV$

$P = 500 \times 3$

$P = 1500$ watt

or

$P = 1.5$ kW Ans.

Ans. c

Solution: 11

$$P = \frac{mgh}{t}$$

$$10 \times 10^3 = \frac{200 \times 10 \times 40}{t}$$

$$t = \frac{8 \times 10^4}{10^4}$$

$$\boxed{t = 8\ \text{sec}}$$ Ans.

Ans. c

Solution: 12

$1\ HP = 746\ W$

so, $P = 10\ HP = 7460\ W = \dfrac{mgh}{t} = \dfrac{(\rho V)gh}{t}$

$$7460 = \frac{\left(1000 \times \frac{22380}{1000}\right) \times 10 \times (20+10)}{t}$$

$$t = \frac{22380 \times 10 \times 30}{7460} = 900\ sec$$

$$\boxed{t = 15\ min}\ \text{Ans.}$$

Ans. c

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