DPP - Daily Practice Problems

Name : ______ Date : ______

Start Time : ______ End Time : ______

PHYSICS 12

SYLLABUS : Work, Energy and Power-1 (Work by constant and variable forces, kinetic and potential energy, work energy theorem)

Max. Marks : 112 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 28 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.20) : There are 20 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 A body is acted upon by a force $\vec{F} = -\hat{i} + 2\hat{j} + 3\hat{k}$. The work done by the force in displacing it from (0,0,0) to (0,0,4m) will be -

(a) 12 J (b) 10 J
(c) 8 J (d) 6 J

Q.2 The work done in pulling a body of mass 5 kg along an inclined plane (angle 60º) with coefficient of friction 0.2 through 2 m, will be -

(a) 98.08 J (b) 94.08 J
(c) 90.08 J (d) 91.08 J

Q.3 A force $\vec{F} = (7 - 2x + 3x^2)$ N is applied on a 2 kg mass which displaces it from x = 0 to x = 5 m. Work done in joule is -

(a) 70 (b) 270 (c) 35 (d) 135

Q.4 An automobile of mass m accelerates from rest. If the engine supplies a constant power P, the velocity at time t is given by -

(a) $v = \frac{Pt}{m}$ (b) $v = \frac{2Pt}{m}$ (c) $\sqrt{\frac{Pt}{m}}$ (d) $\sqrt{\frac{2Pt}{m}}$

Q.5 In the above question, the position (s) at time (t) is given by -

(a) $\left(\frac{2Pt}{m}\right)t$ (b) $\left(\frac{8P}{9m}\right)^{1/2} t^{3/2}$

(c) $\left(\frac{9P}{8m}\right)^{1/2} t^{1/2}$ (d) $\left(\frac{8P}{9m}\right)^{1/2} t$

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

Q.6 A particle moving in a straight line is acted by a force, which works at a constant rate and changes its velocity from u to v in passing over a distance x. The time taken will be -

(a) $x = \frac{v-u}{v^2+u^2}$ (b) $x\left(\frac{v+u}{v^2+u^2}\right)$

(c) $\frac{3}{2}(x)\left(\frac{v^2-u^2}{v^3-u^3}\right)$ (d) $x\left(\frac{v}{u}\right)$

Q.7 A chain of linear density 3 kg /m and length 8 m is lying on the table with 4 m of chain hanging from the edge. The work done in lifting the chain on the table will be -
(a) 117.6 J (b) 235.2 J (c) 98 J (d) 196 J

Q.8 The work done in lifting water from a well of depth 6 m using a bucket of mass 0.5 kg and volume 2 litre, will be-
(a) 73.5 J (b) 147 J (c) 117. 6 J (d) 98 J

Q.9 An object of mass 5 kg falls from rest through a vertical distance of 20 m and reaches a velocity of 10 m/s. How much work is done by the push of the air on the object ? ($g = 10\ m/s^2$).
(a) 350 J (b) 750 J (c) 200 J (d) 300 J

Q.10 A boy pulls a 5 kg block 20 metres along a horizontal surface at a constant speed with a force directed 45° above the horizontal. If the coefficient of kinetic friction is 0.20, how much work does the boy do on the block?
(a) 163.32 J (b) 11.55 J
(c) 150 J (d) 115 J

Q.11 A uniform chain is held on a frictionless table with one-fifth of its length hanging over the edge. If the chain has a length ℓ and a mass m, how much work is required to pull the hanging part back on the table ?
(a) $mg\ell / 10$ (b) $mg\ell / 5$
(c) $mg\ell / 50$ (d) $mg\ell / 2$

Q.12 A bus of mass 1000 kg has an engine which produces a constant power of 50 kW. If the resistance to motion, assumed constant is 1000 N. The maximum speed at which the bus can travel on level road and the acceleration when it is travelling at 25 m/s, will respectively be -
(a) 50 m/s, 1.0 m/s^2 (b) 1.0 m/s, 50 m/s^2
(c) 5.0 m/s, 10 m/s^2 (d) 10 m/s, 5m/s^2

Q.13 The power output of a $_{92}U^{235}$ reactor if it takes 30 days to use up 2 kg of fuel and if each fission gives 185 MeV of energy (Avogadro number = 6×10^{23}/mole) will be -
(a) 58.4 MW (b) 5.84 MW
(c) 584 W (d) 5840 MW

Q.14 The stopping distance for a vehicle of mass M moving with a speed v along a level road, will be -
(μ is the coefficient of friction between tyres and the road)
(a) $\frac{v^2}{\mu g}$ (b) $\frac{2v^2}{\mu g}$ (c) $\frac{v^2}{2\mu g}$ (d) $\frac{v}{\mu g}$

Q.15 The earth circles the sun once a year. How much work would have to be done on the earth to bring it to rest relative to the sun, (ignore the rotation of earth about - its own axis) Given that mass of the earth is 6×10^{24} kg and distance between the sun and earth is 1.5×10^8 km-
(a) 2.7×10^{33} (b) 2.7×10^{24}
(c) 1.9×10^{23} (d) 1.9×10^{24}

Q.16 A particle of mass m is moving in a horizontal circle of radius r, under a centripetal force equal to $(-k/r^2)$, where k is a constant. The total energy of the particle is -
(a) k/2r (b) –k/2r
(c) kr (d) –k/r

Q.17 The work done by a person in carrying a box of mass 10 kg through a vertical height of 10 m is 4900 J. The mass of the person is -
(a) 60 kg (b) 50 kg
(c) 40 kg (d) 130 kg

Q.18 A uniform rod of length 4 m and mass 20 kg is lying horizontal on the ground. The work done in keeping it vertical with one of its ends touching the ground, will be -
(a) 784 J (b) 392 J (c) 196 J (d) 98 J

Q.19 If g is the acceleration due to gravity on the earth's surface, the gain in the potential energy of an object of mass m raised from surface of the earth to a height equal to radius R of the earth is - [M = mass of earth]
(a) $\frac{GMm}{2R}$ (b) $\frac{GM}{R}$ (c) $\frac{GMm}{R}$ (d) $\frac{GM}{2R}$

RESPONSE GRID					
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	

Space for Rough Work

Q.20 The potential energy between two atoms in a molecule is given by, $U_{(x)} = \frac{a}{x^{12}} - \frac{b}{x^6}$, where a and b are positive constant and x is the distance between the atoms. The atoms is an stable equilibrium, when-

(a) $x = 0$
(b) $x = \left(\frac{a}{2b}\right)^{1/6}$
(c) $x = \left(\frac{2a}{b}\right)^{1/6}$
(d) $x = \left(\frac{11a}{5b}\right)^{1/6}$

DIRECTIONS (Q.21-Q.22) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct
(b) 1 and 2 are correct
(c) 2 and 4 are correct
(d) 1 and 3 are correct

Q.21 A man pushes a wall and fails to displace it. Choose incorrect statements related to his work

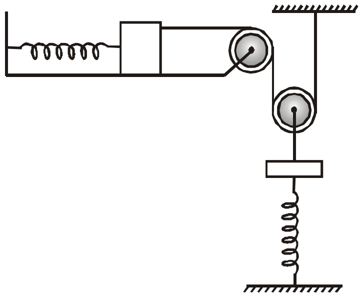
(1) Negative work
(2) Positive but not maximum work
(3) Maximum work
(4) No work at all

Q.22 Choose the correct options –

(1) The work done by forces may be equal to change in kinetic energy
(2) The work done by forces may be equal to change in potential energy
(3) The work done by forces may be equal to change in total energy
(4) The work done by forces must be equal to change in potential energy.

DIRECTIONS (Q.23-Q.25) : Read the passage given below and answer the questions that follows :

In the figure shown, the system is released from rest with both the springs in unstretched positions. Mass of each block is 1 kg and force constant of each spring is 10 N/m.



Q.23 Extension of horizontal spring in equilibrium is:
(a) 0.2 m
(b) 0.4 m
(c) 0.6 m
(d) 0.8 m

Q.24 Extension of vertical spring in equilibrium is
(a) 0.4 m
(b) 0.2 m
(c) 0.6 m
(d) 0.8 m

Q.25 Maximum speed of the block placed horizontally is:
(a) 3.21 m/s
(b) 2.21 m/s
(c) 1.93 m/s
(d) 1.26 m/s

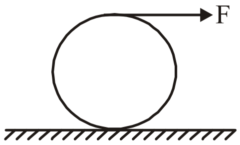
DIRECTIONS (Qs. 26-Q.28) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(c) Statement -1 is False, Statement-2 is True.
(d) Statement -1 is True, Statement-2 is False.

RESPONSE GRID	
	20. ⓐⓑⓒⓓ 21. ⓐⓑⓒⓓ 22. ⓐⓑⓒⓓ 23. ⓐⓑⓒⓓ 24. ⓐⓑⓒⓓ
	25. ⓐⓑⓒⓓ

Space for Rough Work

Q.26 As shown in the figure, a uniform sphere is rolling on a horizontal surface without slipping, under the action of a horizontal force F.



Statement - 1 : Power developed due to friction force is zero.

Statement - 2 : Power developed by gravity force is non-zero.

Q.27 Statement - 1 : Sum of work done by the Newton's 3rd law pair internal forces, acting between two particles may be zero.

Statement - 2 : If two particles undergo same displacement then work done by Newton's 3rd law pair forces on them is of opposite sign and equal magnitude.

Q.28 Statement - 1: A particle moves along a straight line with constant velocity. Now a constant non-zero force is applied on the particle in direction opposite to its initial velocity. After the force is applied, the net work done by this force may be zero in certain time intervals.

Statement - 2 : The work done by a force acting on a particle is zero in any time interval if the force is always perpendicular to velocity of the particle.

RESPONSE GRID	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 12 - PHYSICS			
Total Questions	28	Total Marks	112
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	28	Qualifying Score	44
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

12

(1) **(a)** Here $\vec{F} = -\hat{i} + 2\hat{j} + 3\hat{k}$ &

$\vec{d} = (0-0)\,\hat{i} + (0-0)\,\hat{j} + (4-0)\,\hat{k} = 4\hat{k}$

$\therefore$ W (Work done) $= \vec{F}.\vec{d} = (-\hat{i} + 2\hat{j} + 3\hat{k})\,.\,4\hat{k} = 12$ J

(2) **(a)** The minimum force with a body is to be pulled up along the inclined plane is mg $(\sin\theta + \mu\cos\theta)$

Work done, $W = \vec{F}.\vec{d}$

$= Fd\cos\theta = mg(\sin\theta + \mu\cos\theta) \times d$

$= 5 \times 9.8\,(\sin 60^\circ + 0.2\cos 60^\circ) \times 2 = 98.08$ J

(3) **(d)** $W = \int_0^5 F\,dx = \int_0^5 (7 - 2x + 3x^2)\,dx$

$$= [7x]_0^5 - \left[\frac{2x^2}{2}\right]_0^5 + \left[\frac{3x^3}{3}\right]_0^5 = 135 \text{ Joule}$$

(4) **(d)** Given that, power $= Fv = P =$ constant

or $m\frac{dv}{dt}v = P$ $\quad$ [as $F = ma = \frac{mdv}{dt}$]

or $\int v\,dv = \int \frac{P}{m}dt \Rightarrow \frac{v^2}{2} = \frac{P}{m}t + C_1$

Now as initially, the body is at rest i.e $v = 0$ at $t = 0$ so, $C_1 = 0$

$\therefore\ v = \sqrt{\frac{2Pt}{m}}$

(5) **(b)** By definition $v = \frac{ds}{dt}$ $\quad$ or $\frac{ds}{dt} = \left(\frac{2Pt}{m}\right)^{1/2}$

$$\Rightarrow \int ds = \int\left(\frac{2Pt}{m}\right)^{1/2} dt \Rightarrow s = \left(\frac{2P}{m}\right)^{1/2}\frac{2}{3}t^{3/2} + C_2$$

Now as $t = 0$, $s = 0$, so $C_2 = 0$

$$s = \left(\frac{8P}{9m}\right)^{1/2} t^{3/2}$$

(6) **(c)** The force acting on the particle $= \frac{mdv}{dt}$

Power of the force $= \left(\frac{mdv}{dt}\right)v = k$ (constant)

$\Rightarrow m\frac{v^2}{2} = kt + c$ $\quad$ .....(1)

At $t = 0$, $v = u$ $\quad \therefore\ c = \frac{mu^2}{2}$

Now from (1), $m\frac{v^2}{2} = kt + \frac{mu^2}{2}$

$\Rightarrow \frac{1}{2}m(v^2 - u^2) = kt$ $\quad$ .....(2)

Again $\frac{mdv}{dt}v = k$

$\Rightarrow m.v\frac{dv}{dx}v = k \Rightarrow mv^2\,dv = kdx$

Intergrating,

$\frac{1}{3}m(v^3 - u^3) = kx$ $\quad$ .....(3)

From (2) and (3),

$$t = \frac{3}{2}\left(\frac{v^2 - u^2}{v^3 - u^3}\right)(x)$$

(7) **(b)** Mass of the chain hanging $= 4 \times 3 = 12$ kg

Shift in center of gravity $= 4/2 = 2$m

Work done, $W = mgh = 12 \times 9.8 \times 2 = 235.2$ J

(8) **(b)** Mass of 2 litre, water $= 2$ kg

Total mass to be lifted $= 2 + 0.5 = 2.5$ kg

Work done, $W = mgh = 2.5 \times 9.8 \times 6 = 147$ J

(9) **(b)** The following two forces are acting on the body

(i) Weight mg is acting vertically downward

(ii) The push of the air is acting upward.

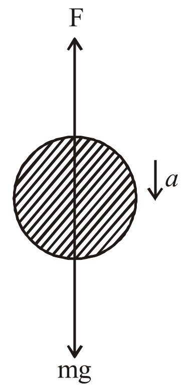
As the body is accelerating downward, the resultant force is $(mg - F)$

Workdone by the resultant force to fall through a vertical distance of $20\text{ m} = (mg - F) \times 20$ joule

Gain in the kinetic energy $= \frac{1}{2}mv^2$

Now the workdone by the resultant force is equal to the change in kinetic energy i.e.

$(mg - F)\,20 = \frac{1}{2}mv^2$ (From work-energy theorem)



or $(50 - F)\,20 = \frac{1}{2} \times 5 \times (10)^2$

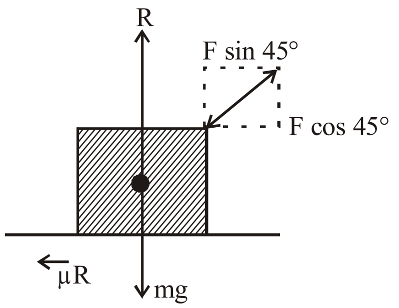
or $50 - F = 12.5$ or $F = 50 - 12.5$

$\therefore F = 37.5\,N$

Work done by the force $= -37.5 \times 20 = -750$ joule

(The negative sign is used because the push of the air is upwards while the displacement is downwards.)

(10) **(a)**



The different forces acting on the block are shown in fig. Now we have

$R + F \sin 45° = m\,g$ ....(1)

$F \cos 45° = \mu R$ ....(2)

From equation (1) and (2)

$$\therefore\ F = \frac{\mu\ mg}{\cos 45° + \mu \sin 45°}$$

Substituting the given values, we have

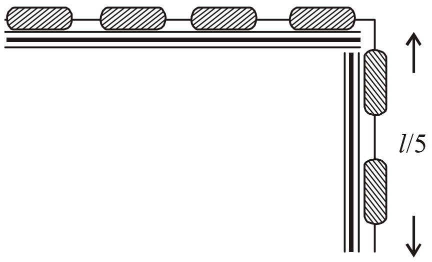
$$F = \frac{0.20 \times (5 \times 9.78)}{(0.707) + (0.20 \times 0.707)} = 11.55\,N$$

The block is pulled through a horizontal distance $r = 20$ metre

Hence, the work done

$W = F \cos 45° \times r = (11.55 \times 0.707) \times 20 = 163.32$ Joule

(11) **(c)**



Mass of the hanging part of the chain = (m/5) The weight mg/5 acts at the centre of gravity of the hanging chain, i.e., at a distance $= \ell/10$ below the surface of a table.

The gain in potential energy in pulling the hanging part on the table.

$$U = \frac{mg}{5} \times \frac{\ell}{10} = \frac{mg\ell}{10}$$

$\therefore$ Work done $= U = mg\,\ell/50$

(12) **(a)** At maximum speed all the power is used to overcome the resistance to motion. Hence if the maximum speed is v, then $50000 = 1000 \times v$ or $v = 50$ m/s

At 25 m/s, let the pull of the engine be P, then the power

$$\text{or } P = \frac{50,000}{25} = 2000\,N$$

Now resultant force $= 2000 - 1000 = 1000\,N$

Applying Newton's law ; $F = ma$, we have

$1000 = 1000\,a$ or $a = 1.0\ m/s^2$

(13) **(a)** 1 mole i.e. 235 gm of uranium contains 6×10^{23} atoms, so 2 kg i.e. 2×10^3 gm of uranium will contain

$$= \frac{2 \times 10^3 \times 6 \times 10^{23}}{235} \text{ atoms} = 5.106 \times 10^{24} \text{ atoms}$$

Now as in each fission only one uranium atom is consumed i.e. Energy yield per uranium atom

$= 185\ MeV = 185 \times 1.6 \times 10^{-13}\ J = 2.96 \times 10^{-11}\ J$

So Energy produced by 2 kg uranium

= (No. of atoms) × (energy /atom)

$= 5.106 \times 10^{24} \times 2.96 \times 10^{-11} = 1.514 \times 10^{-14}\ J$

As 2 kg uranium is consumed in 30 days i.e. 1.51×10^{-14} J of energy is produced in the reactor in 30 days i.e. 2.592×10^6 sec

So, power output of reactor

$$= \frac{E}{t} = \frac{1.514 \times 10^{14}\ J}{2.592 \times 10^6\ S} = 58.4\ MW$$

(14) **(c)** When the vehicle of mass m is moving with velocity v, the kinetic energy of the where $K = \frac{1}{2}mv^2$ and if S is the stopping distance, work done by the friction

$W = FS \cos\theta = \mu\ MgS \cos 180° = -\mu\ MgS$

So by Work-Energy theorem,

$W = \Delta K = K_f - k_i$

$$\Rightarrow -\mu\ MgS = 0 - \frac{1}{2}Mv^2 \Rightarrow S = \frac{v^2}{2\mu g}$$

(15) **(a)** As $T = (2\pi/\omega)$,

so $\omega = 2\pi/(3.15 \times 10^7) = 1.99 \times 10^{-7}$ rad/s

Now $v = r\omega = 1.5 \times 10^{11} \times 1.99 \times 10^{-7} \approx 3 \times 10^4$ m/s

Now by work - energy theorem ,

$$W = K_f - K_i = 0 - \frac{1}{2}mv^2$$

$$= -\frac{1}{2} \times 6 \times 10^{24}\,(3 \times 10^4)^2 = -2.7 \times 10^{33}\ J$$

Negative sign means force is opposite to the motion.

(16) **(b)** As the particle is moving in a circle, so

$$\frac{mv^2}{r} = \frac{k}{r^2} \quad \text{Now K.E} = \frac{1}{2}mv^2 = \frac{k}{2r}$$

Now as $F = -\frac{dU}{dr}$

$$\Rightarrow \text{P.E, } U = -\int_{\infty}^{r} F\,dr = \int_{\infty}^{r} +\left(\frac{k}{r^2}\right) dr = -\frac{k}{r}$$

So total energy $= U + K.E = -\frac{k}{r} + \frac{k}{2r} = -\frac{k}{2r}$

Negative energy means that particle is in bound state .

(17) **(c)** Let the mass of the person is m

Work done, W = P.E at height h above the earth surface

$= (M + m)\,gh$

or $4900 = (M + 10)\,9.8 \times 10$ or $M = 40$ kg

(18) **(b)** As the rod is kept in vertical position the shift in the centre of gravity is equal to the half the length = $\ell/2$

Work done $W = mgh = mg\frac{\ell}{2} = 20 \times 9.8 \times \frac{4}{2} = 392$ J

(19) **(a)** We know that the increase in the potential energy

$$\Delta U = GmM\left[\frac{1}{R} - \frac{1}{R'}\right]$$

According to question $R' = R + R = 2R$

$$\Delta U = GMm\left[\frac{1}{R} - \frac{1}{2R}\right] = \frac{GMm}{2R}$$

(20) **(c)** In first case, $W_1 = \frac{1}{2}m(v_1)^2 + mgh$

$= \frac{1}{2}m(12)^2 + m \times 10 \times 12$

$= 72\,m + 120\,m = 192\,m$

and in second case, $W_2 = mgh = 120$ m

The percentage of energy saved

$$= \frac{192m - 120m}{192m} \times 100 = 38\%$$

(21) **(c)** Given that, $U(x) = \frac{a}{x^{12}} - \frac{b}{x^6}$

We know $F = -\frac{du}{dx} = (-12)\,a\,x^{-13} - (-6b)\,x^{-7} = 0$

or $\frac{6b}{x^7} = \frac{12a}{x^{13}}$

or $x^6 = 12a/6b = 2a/b$ or $x = \left(\frac{2a}{b}\right)^{1/6}$

(22) **(a)** W = 0

(23) **(b)**

(1) There will be an increase in potential energy of the system if work is done upon the system by a conservative force.

(2) The work done by the external forces on a system equals the change in total energy

(24) **(a)**

(1) The work done by all forces equal to change in kinetic energy

(2) The work done by conservative forces equal to change in potential energy

(3) The work done by external and nonconservative forces equal to change in total energy

(25) (b), (26) (b), 27. (c)

For vertical block

$mg = kx + 2T$ .... (1)

For horizontal block

$T = k(2x)$ .... (2)

From eq. (1) and eq. (2)

$$x = \frac{mg}{5k} = 0.2m$$

∴ Extension of vertical spring = 0.2m

Extension of horizontal spring = 2x = 0.4m

From conservation of energy

$$mgx = \frac{1}{2}kx^2 + \frac{1}{2}k(2x)^2 + \frac{1}{2}mv^2 + \frac{1}{2}m(2v)^2$$

$$mgx = \frac{3}{2}kx^2 + \frac{3}{2}mv^2$$

$$\frac{7}{10}mgx = \frac{3}{2}mv^2$$

$$v = \sqrt{\frac{7}{15}gx}$$

Required speed = 2v = 1.9 m/s

(28) **(d)** Statement – 1 is true but statement – 2 is false.

(29) **(a)** Work done by action reaction force may be zero only if displacement of both bodies are same.

(30) **(b)** Both statements are true and independent.