WEEKLY TEST MEDICAL PLUS -03 TEST - 09 RAJPUR SOLUTION Date 15-09-2019

[PHYSICS]

1.

As discussed in question 9, tension in the arms will be minimum, when $\cos\theta$ is maximum (= 1) or $\theta = 0°$, *i.e.*, angle between arms $= 0° (T_{min.} = W/2)$.

2.

Rate of change of momentum $= v \times \frac{\Delta m}{\Delta t}$

or $\frac{dp}{dt} = \frac{8}{1000} \times \frac{7}{100} \times \frac{10}{56} = 10^{-4}$ N

or Average force $= 10^{-4}$ N

3.

$$Mg - T = Ma$$

$\therefore$ $T = M(g-a) = Mg\left(1 - \frac{a}{g}\right)$

or $\frac{2}{5}Mg = Mg\left(1 - \frac{a}{g}\right)$

or $\frac{a}{g} = 1 - \frac{2}{5} = \frac{3}{5}$

$\therefore$ $a = 0.6g$.

4.

$$\mu = \tan\theta\left[1 - \frac{1}{n^2}\right]$$

Here, $\theta = 45°$ and $n = 2$

$\therefore$ $\mu = \tan 45°\left[1 - \frac{1}{2^2}\right]$

$$= 1 - \frac{1}{4} = \frac{3}{4} = 0.75$$

5.

Because the raindrop is falling with uniform velocity, there will be no change in its actual weight, *i.e.*,

$$\text{Weight} = mg = \frac{0.2}{1000} \times 10 = 0.002 \text{ N}$$

6.

There occurs a loss in mass at the rate of $\Delta m/\Delta t$.

Hence, loss in mass in time $t = \frac{\Delta m}{\Delta t} \times t$

Mass of the rocket after time $t = M_0 - \frac{\Delta m}{\Delta t} \times t$

7.

8. Because of continuous decrease in the mass of the rocket, its acceleration increases inspite of force acting on remaining same.

9. Given that $mg\sin\theta = 8$. In order to move it upwards with the same acceleration, we need to apply a force F such that:

$$F - mg\sin\theta = mg\sin\theta$$

$\therefore$ $$F = 2mg\sin\theta = 16\text{ N}$$

10.

Accelerations of the skaters will be in the ratio $\frac{F}{4} : \frac{F}{5}$, *i.e.*, $5 : 4$

Now according to the equation, $s = 0 + \frac{1}{2}at^2$ we get;

$$\frac{s_1}{s_2} = \frac{a_1}{a_2} = \frac{5}{4}$$

11.

Mass of the packet $M = \frac{W}{g}$

Now, $F - W = M \times a$

or $F - W = \frac{W}{g} \times 2g = 2W$

$\therefore$ $F = 3W$

12.

Change in momentum of each bullet $= 5[v - (-v)]$

$$\Delta p = 10v$$

Because 10 bullets are fired per second, hence change in momentum per sec

i.e., $F = \Delta p \times 10 = 10v \times 10$

This force will be directed upwards and will balance the weight of the dish,

i.e., $10v \times 10 = 10 \times 980$

$\therefore$ $v = 98\text{ cm/sec}$

13. $\frac{dM}{dt} = \frac{M(a+g)}{u} = \frac{6000(20+10)}{1000} = 180\text{ kg/s}$

14. For a body to be in equilibrium, it should exist both in translational and rotational equilibrium.

For translational equilibrium, $\Sigma F = 0$

and for rotational equilibrium, $\Sigma \tau = 0$

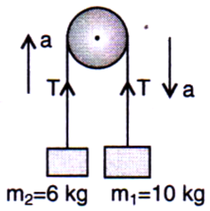
15.

$m_1 g - T = m_1 a$

and $T - m_2 g = m_2 a$

Adding two equations,

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



and $T = m_2(g + a)$

$$= \frac{2m_1 m_2}{(m_1 + m_2)} g$$

$$= \frac{2 \times 10 \times 6}{10 + 6} \times 9.8 = 73.5\text{ N}.$$

On integrating, we get; $W = 530\,\text{mJ}$

16.

Change in momentum in one sec, *i.e.,*

F = change in momentum per bullet × no. of bullets fired per second

$$= mv \times n = mnv$$

17.

Reading of spring balance = tension

Tension, $T = \dfrac{2m_1m_2g}{m_1+m_2} = \dfrac{2\times2\times2\times9.8}{2+2}$

$$= 19.6\text{ N} = \frac{19.6}{9.8}\text{kgf} = 2\text{kgf}$$

18.

The customer gets $\dfrac{W_1+W_2}{2}$ instead of $\sqrt{W_1W_2}$

Now, $\dfrac{W_1+W_2}{2} - \sqrt{W_1W_2} = \left[\dfrac{W_1+W_2-2\sqrt{W_1W_2}}{2}\right]$

$$= \frac{(\sqrt{W_1}-\sqrt{W_2})^2}{2}$$

As $(\sqrt{W_1}-\sqrt{W_2})^2$ is + ve, hence the customer gets more than his due and the tradesman loses.

19.

Firstly, when the cap is opened, gas and liquid rush out and as a reaction weight increases and then it decreases.

20.

Let the acceleration be a.

Then $20 = 0 + 0.1\times a$

$\therefore$ $a = 200\,\text{m s}^{-2}$

and Force $= 0.150\times200\text{N} = 30\text{N}$

21.

Tension $= m(g+a)$

$$= 500(9.8+2) = 5900\text{N}$$

22.

Momentum of one bullet

$$= mv = 20\times10^{-3}\times300$$

$$p = 6\text{ kg-m/sec.}$$

N = Number of bullets/sec = 4

$\therefore$ $\dfrac{dp}{dt}$ = change of momentum/sec or force

$$= Np = 4\times6 = 24\text{ N}$$

23.

We know that friction of ice is small and larger reaction cannot be obtained. Therefore, to avoid slipping, while walking on ice, one should take smaller steps to produce large normal reaction.

24.

Normally, with increase in smoothness, friction decreases. However, if the surfaces are made too smooth by polishing and cleaning, the bonding force of adhesion will increase and so friction will increase.

25.

Friction is a conservative force, *i.e.,* work done against friction is path dependent. In its presence mechanical energy is not conserved as it converts kinetic energy of a body into heat. Thus, friction reduces efficiency of a machine.

26.

Tyres are made circular to reduce the frictional force because rolling friction < sliding friction.

27.

When a man walks on a rough surface, it is the frictional force which is responsible for motion, *i.e.,* required angle between frictional force and instantaneous velocity is zero.

28.

Vehicles are streamlined to reduce the frictional force offered by the surrounding air, *i.e.*, reduce the fluid friction (also called WET friction). Friction between fluid and solid is called as wet friction.

29.

Force of friction, $F = \mu R = \mu mg$

Retardation due to friction, $|a| = \frac{F}{m} = \frac{\mu mg}{m} = \mu g$

Now, $u = 10 \text{ m s}^{-1}, s = 50 \text{ m}, v = 0,$

$a = -\mu g, \; g = 10 \text{ m s}^{-2}$

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

$(0)^2 = (10)^2 + 2(-10\mu)(50)$

$\therefore \quad \mu = 0.1$

30.

When the cube is to be moved up, the minimum force needed is given by:

$F = mg\sin\theta + \mu R = mg\sin\theta + \mu mg\cos\theta$

$= 10\sin\theta + 0.6 \times 10\cos\theta = 10 \times \frac{3}{5} + 0.6 \times 10 \times \frac{4}{5}$

$= 10.8 \text{ N}$

31.

$F - Mg = Ma$

$8000 = 2000a$

$\therefore$ Acceleration is 4 ms^{-2} upwards.

32.

Kinetic friction is constant, hence frictional force will remain same (= 10 N) .

33.

Frictional force $= \mu mg$ and Centripetal force $= \frac{mv^2}{r}$

$\therefore \quad \mu mg = \frac{mv^2}{r}$ or $r = \frac{v^2}{\mu g} = \frac{12 \times 12}{0.4 \times 10} = 36 \text{ m}$

34.

Let a = acceleration of the body.

$v^2 = u^2 + 2as$ or $0 = 1 + 2a \times 5$

$\therefore \quad a = -\frac{1}{10} = -0.1\,\text{m/s}^2$ or Retardation $= 0.1\,\text{m/s}^2$

Now, F = mass $\times 0.1 = 0.1\text{m}$

Normal reaction, R = weight of the body $= mg$

$= m \times 9.8\,\text{N}$

$\therefore \quad \mu = \frac{F}{R} = \frac{m \times 0.1}{m \times 9.8} = \frac{1}{98} = 0.0102$

35.

$W = Fs = \mu Rs = \mu mgs$

$= 0.2 \times 50 \times 9.8 \times 1 = 98\,\text{J}$

$R = mg\cos\alpha$

36.

37.

38.

$u = 72\,\text{km/h} = 20\,\text{m/s},\ v = 0$

$a = \mu g = 0.5 \times 10\,\text{m/s}^2$

From, $v^2 = u^2 - 2as$

$\therefore \quad (0)^2 = (20)^2 - 2 \times 0.5 \times 10 \times s$

$\therefore \quad s = \frac{20 \times 20}{2 \times 0.5 \times 10} = 40\,\text{m}.$

39.

$s = 2\,\text{m},\ u = 80\,\text{m/s},\ v = 0$

From, $v^2 = u^2 - 2as$

$\therefore \quad (0)^2 = (80)^2 - 2 \times a \times 2$

or $a = \frac{80 \times 80}{4} = 1600\,\text{m/s}^2$

40.

$$F = \frac{d}{dt}(Mv) = v\frac{dM}{dt} + M\frac{dv}{dt}$$

As v is a constant, $F = v\frac{dM}{dt}$

But $\frac{dM}{dt} = M$ kg/s

$\therefore$ To keep the conveyer belt moving at v m/s,

Force needed $= vM$ newton

41.

42.

Time period of a simple pendulum is given ;

$$T = 2\pi\sqrt{\frac{l}{g}} \quad \text{or } T \propto \sqrt{\frac{l}{g}}$$

when the elevator is accelerating downwards, the net gravitational acceleration is $(g - a)$. So, the time period when elevator is accelerating downwards, is greatest.

43.

As per Newton's third law of motion, when a horse pulls a wagon, the force that causes the horse to move forward is the force the ground exerts on it.

44.

Change in momentum,

$$\Delta p = mv - (-mv) = 2mv$$
$$= 2 \times 0.25 \times 10 = 5 \text{ kg m s}^{-1}$$

Force × Time = Change in momentum

$$\therefore \quad \text{Force} = \frac{\text{Change in momentum}}{\text{Time}}$$
$$= \frac{5 \text{kg ms}^{-1}}{0.01 \text{s}} = 500 \text{ N}$$

45.

Force of friction, $f = \mu mg$

$$\therefore \quad a = \frac{f}{m} = \frac{\mu mg}{m} = \mu g = 0.5 \times 10 = 5 \text{m s}^{-2}$$

Using, $v^2 - u^2 = 2aS$

$$0^2 - 2^2 = 2(-5) \times S$$
$$S = 0.4 \text{ m}$$

[CHEMISTRY]

46.

$$W = q_V = -nC_V(T_2 - T_1)$$
$$3000 = -1 \times 20 \times (T_2 - 300) \quad \Rightarrow \quad T_2 = \mathbf{150\ K}$$

47.

System is closed and insulated, $Q = 0$ (heat change between system and surrounding). $\Delta E = W + Q = W$ (Since $Q = 0$)

48.

$$q_P = nC_P\Delta T$$
$$\Delta T = \frac{1000}{\left(\frac{100}{18}\right) \times 75} = \mathbf{2.4\ K}$$

49.

Mixture of monoatomic gases will still have monoatomic gases. \

50.

51.

During adiabatic process, no heat is exchanged with surrounding. Hence, $q = 0$.

From $\Delta E = q + W$ (Work done on the system)

$\Delta E = W$ (Since, $q = 0$)

52.

1 Litre-atm = 24.2 calorie

1 calorie = 4.1868 Joule

1 Joule = 10^7 erg

53.

More negative the enthalpy of formation, more is the stability.

54.

$$q = 300 \text{ calorie}$$
$$W = -P\Delta V = -1 \times 10 \text{ litre-atm} = -10 \times 24.2 \text{ cal} = -242 \text{ cal}$$
$$\Delta E = q + W = 300 - 242 = \mathbf{58\ cal}$$

55.

ΔH for isothermal free expansion is zero.

56.

57.

$$\frac{V_2}{V_1} = \frac{1}{10}$$

$$W \text{ (on the system)} = -2.303nRT\log\frac{V_2}{V_1}$$

$$= -2.303 \times 1 \times 2 \times 500 \log\frac{1}{10} \text{ cal}$$

$$= +\frac{2.303 \times 2 \times 500}{1000} \text{ kcal} = \mathbf{+2.303\ kcal}$$

58.

In cyclic system, $\Delta E = 0, \Delta H = 0$.

Work done by the system = − 550 kJ.

$$\Delta E = q + W$$

$$\Rightarrow \quad 0 = q - 550 \quad \Rightarrow \quad \mathbf{q = 550\ kJ}$$

59.

$$W = -2.303nRT\log\frac{V_2}{V_1}$$

$$= -2.303 \times 2 \times 8.314 \times 300 \times \log\frac{50}{5} \text{ joule}$$

$$= -11488.285\text{J} \simeq \mathbf{-11.5\ kJ}$$

60.

$$q = +200\text{J}$$

$$W = -P\Delta V = -1 \times (20-10) = -10 \text{ atm L}$$

$$= -10 \times 101.3 \text{ J} = -1013 \text{ J}$$

$$\Delta E = q + W = (200-1013)\text{J} = \mathbf{-813\ J}$$

61.

ΔH for isothermal free expansion is zero.

62.

Volume occupied by molecules of a gas can never be zero.

63.

64.

Leakage of a gas from balloon is related with its expansion by taking energy from attractive forces of molecules. This decreases the temperature.

65. In an adiabatic change, no heat is exchanged between the system and the surroundings.

66. : State function

67. Based on the first law of thermodynamics,

$\Delta U = q + w$

Change in internal energy for a cyclic process is zero, *i.e.*

$\Delta U = 0$.

$\therefore \quad q = -w$

68. As it absorbs heat, $q = +208$ J

$$w_{rev} = -2.303nRT\log_{10}\left(\frac{V_2}{V_1}\right)$$

$$w_{rev} = -2.303 \times (0.04) \times 8.314 \times 310 \log_{10}\left(\frac{375}{50}\right)$$

$$\therefore \quad w_{rev} = -207.76 \approx -208 \text{ J}$$

69. $T_3 < T_1$ because cooling takes place on adibatic expansion. Hence, (b) is incorrect.

70 $W = -2.303nRT\log\frac{V_2}{V_1}$

$= -2.303 \times 1 \times 8.314 \times 300 \times \log\frac{20}{10}$

$= -2.303 \times 8.314 \times 300 \times 0.3010 = -1729$ joules

Work done = – 1729 joules

71. Volume depends on the mass of the system.

72.

73. No work is done along the path AB because this process is isochoric (for isochoric process V = 0

$\therefore$ work done $= PdV = 0$).

Thus, the work done $dw = P_B(V_D - V_A)$

$= 8\times10^4(5\times10^{-3} - 2\times10^{-3})$

$= 8\times10^4 \times 3\times10^{-3}\,J = 240\,J$

The energy absorbed by the system

$= (dq)_{AB} + (dq)_{BC} = 600 + 200 = 800\,J$

The change in internal energy $dE = dq - dw$

$dE = 800 - 240 = 560\,J$

74. $W = -\Delta 2.303\ \Delta nRT\ \log\frac{P_1}{P_2}$

$W = -2.303\times1\times0.082\times300 lof\frac{1}{10}$

$W = -1381.9$ cal

75.

76.

$W_{expansion} = -P\Delta V$

$= -(1\times10^5\,Nm^{-2})[(1\times10^{-2} - 1\times10^{-3})\,m^3]$

$= -10^5 \times (10\times10^{-3} - 1\times10^{-3})\,Nm$

$= -10^5 \times 9\times10^{-3}\,J = -9\times10^2\,J = \mathbf{-900\ J}$

77.

78.

$W_{rev} > W_{irrev}$; Thus, there will be more cooling in reversible process.

79.

80.

$q = +40.65\ kJ\ mol^{-1}$

$W_{exp.} = -3.1\,kJ$

$\Delta E = q + W$

$= 40.65 - 3.1 = \mathbf{37.55\ kJ}$

81.

As the system starts from A and reaches to A again, whatever the stages may be net energy change is **zero**.

82.

83

84

85. (c) During isothermal expansion of an ideal gas against vacuum is zero because expansion is isothermal. The reason, that volume occupied by the molecules of an ideal gas is zero, is false.

86. (a) it is fact that absolute values of internal energy of substances can not be determined. It is also true that to determine exact values of constituent energies of the substance is impossible.

87. (b) Mass and volume are extensive properties. mass/volume is also an extensive parameter. Here, both assertion and reason are true.

88.

89.

$$W = -P\Delta V = -3\,\text{atm} \times (6-4)\,\text{dm}^3 = -6\,\text{atm L} = -6 \times 101.325\,\text{J} = -\mathbf{608\ J}$$

90.