|  |  |  |  |
| --- | --- | --- | --- |
| **Qn** | **Answer** | | **Marks** |
| 1 (a) | (i) A body is said to move with uniform velocity if its displacement changes by the same amounts in equal time intervals, irrespective of the length of the time interval.  Time  Displacement | | 1 |
| (ii) | | 1 |
| (iii) … a particle set off at an angle to the horizontal and undergoing an acceleration which is constant both in magnitude and direction. | | 1 |
| (iv) If a particle, moving along a straight line with constant acceleration, a, has a velocity u initially (i.e at time t = 0) its velocity at any subsequent instant, t, is given by  *Final velocity = initial velocity + increase in velocity*  **∴** *v = u + at* …………………………………. (1)  The displacement, ***s***, of the particle during this time is given by  *Displacement = Average velocity* x *time*  **∴** *s = ½(u + v)* x *t*  But from (1) above, v = u + at  **∴** *s = (u + at + u)t* | | 1  1  1 |
| (b) | (i) When the particle lands, its vertical displacement is -200 m.  Let t = time taken.  Then, using s = ut -  , we have  -200 = 0 - x 9.81t  ∴ t =  Initial velocity, U =  =  = **156.6 m s-1** | | 1  1  1  1 |
| (ii) The horizontal velocity remains the same  The vertical velocity, v = 0 + gt = 9.81 = 62.6 m s-1  θ  u  v  V  The velocity, V =  =  = 168.7 m s-1  θ = tan-1 = tan-10.400 = 21.8o  ∴ the velocity is **168.7 m s-1** at **21.8o** below the horizontal. | | 1  1  1  1  1 |
| (c) | Determination of Centre of Gravity of uniform irregularly shaped laminar.  Laminar  B  Plumb line  C  A  b  c  a   * Three small well-spaced holes A, B and C are made at the edge of the sheet. * The sheet is freely supported on a horizontal pin through one of the holes, say A. * A plumb line is also supported from the same pin.   When both the plumb line and the laminar have settled, a mark **a** is made at the point where the plumb line crosses the edge. A line **Aa** is drawn on the sheet.   * The procedure is repeated with the laminar supported from hole **B** and a mark **b** is made where the plumb line crosses the edges. A line **Bb** is drawn.   The point of intersection of the lines **Aa** and **Bb** is the centre of gravity of the laminar.   * For confirmation, if the laminar is supported from hole C, the plumb line should pass through the point of intersection. | | 1  ½  ½  ½  ½  ½  ½ |
| ***Total = 20*** | | | |
| 2 (a) | (i)   1. The frictional force between two surfaces in contact opposes their relative motion 2. The frictional force is independent of the area of contact and of relative speed of the given surfaces when the normal reaction is constant. 3. The limiting frictional force is proportional to the normal reaction (in the case static friction) | | 1  1  1 |
| (ii)  B  mg  F  R  S  θ   * The block, B, is placed on the surface, S. * S is gently tilted until B is on the point of slipping down the plane. * The angle, θ, between the plane and the horizontal is measured.   The frictional force, F, is then equal to mgsinθ and the normal reaction  R = mgcosθ    NOTE: An alternative experiment that gives the same results shall be accepted. | | ½  ½  1½  ½  ½  ½ |
| (b) | (i) The mass m moves towards its initial position but eventually comes to rest.  This is because friction opposes its motion,  and since the tension in the spring decreases as m moves, eventually it can no longer overcome the friction. So m stops | | ½  1  ½ |
| (ii) The potential energy of the stretched spring is converted into heat as it does work against friction | | 2 |
| (c) | (i)  μF  F  A  60o  30o  30o  B  20N  T  Let a = length of AB  T = tension in the rope  Taking moments about point A, we have  T x a sin30o = 20 x a cos30o  ∴ T =  = **17.32 N** | | 1  1  1  1 |
| (ii) Resolving horizontally, we have  F = T cos60o = 17.32 x 0.5 = 8.66 N  Resolving vertically, we have  μF + T sin60o = 20  ∴ μF = 20 – 17.32 x 0.866 = 5 N  Now, μ =  = **0.577** | | 1  1  1  1 |
| ***Total = 20*** | | | |
| 3 (a) | (i) Tangential velocity is the rate at which the particle describes a distance along the circle while angular velocity is the rate at which the line joining the particle to the centre of the circle sweeps through an angle. | |  |
| θ  r  s  B  A  v  v  O  (ii)  Suppose that in time t, a particle moves from A to B along a circle of centre O. The radius OA sweeps through angle θ, in radians.  The angular velocity, ω =  ……………….. (1)  The period, T, is the time taken to describe the circle once.  Thus, using equation (1) ω =  ∴  ………………………………. (2)  If r is the radius of the circle, then the tangential velocity, v =  Substituting for T from equation (1), we have that  v = rω | | 1  ½  ½  1 |
| (iii)   |  |  | | --- | --- | | Uniform circular motion | Projectile motion | | The speed of the particle remains constant | The speed of the particle changes with time. | | The acceleration is always perpendicular to the velocity of the particle | The direction of the acceleration remains constant as the velocity changes direction. | | | 1  1 |
| (b) | Let u1 = initial velocity of M1  v1 = final velocity of M1  v2 = final velocity of M2  Then M1u1 = M1v1 + M2v2 …………… (1)  ∴  ∴ eu1 = ev1 + v2 ……………… (2)  By considering the coefficient of restitution from Newton’s experimental law  -e(u1 – 0) = v1 – v2  ∴ -e u1 = v1 – v2 ……………….. (3)  Eq(2) + Eq(3): 0 = (1 + e)v1  Since e is a positive constant, v1 = 0  Now, from (1), substituting for v1  M1u1 = M2v2  So the bodies simply exchange their momenta | | 1  1  1  1 |
| (c) | θ  T  mg  U  r  P  (i)  Let U = velocity of the block just after impact  Then 0.030 x 150 = (0.5 + 0.03)U  ∴ U =  = 8.49 m s-1  The minimum tension will be experienced when the block is at the highest point, P.  Let v = velocity of the particle at P  Then mg + Tm = , where Tm = tension  ∴ Tm =  …….. (1)  By conservation of mechanical energy  ½mv2 = ½mU2 – mg.2r  ∴ v2 = U2 – 4gr  = 8.492 – 4 x 9.81 x 0.8 = 40.69 m2s-2  ∴ Tm = m = 0.5 = **20.53 N** | | 1  1  1  1  1 |
| v1  (ii)  Let v1 = velocity when the string is horizontal.  Then ½m = ½mU2 – mgr  ∴  Now, tension T =  = 0.5 = **35.24 N** | | 1  1  1 |
| ***Total =20*** | | | |
| 4 (a) | | (i) … the quantity of heat required to convert 1 kg mass of a substance from liquid to vapour at constant temperature. | 1 |
| (ii)   * The apparatus is set up as shown in the diagram.   Lagging  A  V  Vapour  Vapour jacket  Heater  Water  Condenser   * The setup is switched on and given time to attain steady conditions, with the liquid at its boiling point.   Under these conditions, the heat supplied by the heater is used in evaporating the liquid and offsetting the losses.   * The condensed liquid is then collected in a weighed beaker over a measured time interval.   Let m1 = mass of liquid collected per second  V1 = p.d across the heater coil  I1 = current through the coil  h = heat lost per second  L = specific latent heat of vaporisation of the liquid  Then I1V1 = m1L + h ……………(1)   * The experiment is repeated at new values I2 and V2 of current and p.d respectively.   Let m2 = new mass of liquid collected per second.  Then I2V2 = m2L + h ……………(2)  From (1) and (2)  L = | ½  1  1  1  ½  ½  1  1  ½ |
| (b) | | (i)  Heat supplied = heat gained by water + vessel  Let t = time to attain a temperature of 100oC  Then 500t = 4 x 4200(100 – 25) + 0.5 x 400(100 – 25)  ∴ t =  = **2250 s** | 1  1  1  1 |
| (ii) 500t1 = 4L  ∴ t1 =  = **18,080 s** | 1  2 |
| (iii) Number of kWh = 0.5 x  ∴ Cost = 0.5 x  = **1,130/=** | 1  1 |
| (c) | | Molar heat capacity, c = βT2  Heat required, Q = , where n = number of moles  ∴ Q = 2 = 2  = 2 x ⅓ x 4.6 x 10-4 x 2 = **2.45 x 10-3 J** | 1  1  1 |
| ***Total = 20*** | | | |
| 5 (a) | | (i)  - Choice of a thermometric property and an instrument in which its value can be observed.  - Choice of a fundamental interval. | 1  1 |
| (ii) Advantages: - it is quick-acting  - can measure temperature at a point  Disadvantages: - It is limited to temperatures not beyond its neutral temperature. | 1  1  1 |
| (iii)   * The silica tube containing the resistance wire is dipped into the liquid bath and left there for some minutes. * Then the resistance, Rθ, of the resistance wire is measured on the Wheatstone bridge. * The procedure is repeated when the silica tube is in pure melting ice to find R0, the resistance at the ice point; and when the silics tube is in steam to find R100.   Then the temperature of the bath, θ = | 1  1  1  1 |
| (b) | | (i)  θ = x 100oC  = x 100oC  = x 100oC  = **197.5oC** | 1  1  1  1 |
| (ii) The resistance of the wire and the pressure of the gas at constant volume do not vary exactly in the same way as the temperature changes. | 1 |
| (c) | | (i) For the first set of results, let I1 = 2.00A, V1 = 25.2V, m1 = x 10-3  For the second set of results, let I2 = 2.52A, V2 = 30.0V, m1 = x 10-3  Let h = rate of heat loss  Then I1V1 = m1c(θ2 - θ1) + h …….. (1)  and I2V2 = m2c(θ2 - θ1) + h …….. (2)  ∴ I2V2 - I1V1 = (m2 – m1)c(θ2 - θ1)  ∴ θ2 - θ1 =  =  ∴ θ2 – 15 =  = 8.8oC  ∴ θ2 = 15 + 8.8 = **23.8oC** | ½  ½  1  1  1 |
| (ii) From (1) h = I1V1 - m1c(θ2 - θ1)  = 50.4 -  = 50.4 – 46.2 **4.2 W** | 1  1 |
| ***Total = 20*** | | | |
| 6 (a) | | (i) Wien’s law:  If λm is the wavelength of the peak of the curve for the temperature T kelvin, then λmT = constant = 2.9 x 10-3 m K.  OR: The wavelength of the peak of the curve is inversely proportional to the absolute temperature of the body.  Stefan’s law:  If E is the total power radiated per m2 at a temperature T, then E = σT4  where σ is a constant called the Stefan constant  OR: The total power radiated per m2 is directly proportional to the forth power of the absolute temperature of the body. | 1  1 |
| Incident radiation  (ii)  A cavity in the form of a hollow sphere, with its inside coated with rough black material, and with a small hole in the surface, closed approximates to a black body; and it may be regarded as a perfectly black body.  Radiation that enters the hole surfers several reflections before it meets the hole again, and at every reflection a fraction of it is absorbed. | 1  2  1 |
| Cork held by wax  Cork held by wax  Dull black tin plate  Polished tin plate  (iii)   * Two sheets of tin plate, one polished and the other dull black, are set up vertically a short distance apart. * On the back side of each is fixed a cork by means of wax. * A burner is placed midway between the plates. * As the burner continues burning, eventually the wax on the back of the dull black plate melts and the cork falls while that on the polished plate remains.   *Conclusion:* The dull black plate must have absorbed heat faster than the polished one. So dull black surfaces are better absorbers than polished ones. | 1  ½  ½  ½  ½  1 |
| (b) | | (i) Let rs = radiation of the star = 7.0 x 108 m  R = distance between star and planet = 1.4 x 1011 m  Then, at a distance R the total area receiving the radiation from the star is 4πR2  So: Power radiated by star = power received over area 4πR2  ∴ σA = 4πR2 x 1.4 x 103  ∴ σ.4π = 4πR2 x 1.4 x 103  ∴  = 9.824 x 1014  Ts =  x 103  = **5599 K** | 1  1  1  1 |
| (ii) - The star radiates as a black body  - No radiant energy is lost in the space around the star. | ½  ½ |
| (c) | | (i) Heat transmission in fluids is facilitated by movement of the medium. | 1 |
| (ii) *Land breeze*: This occurs at night  Warm air rising  Land breeze  Land (cool)  Sea  At night the land is cooler than the sea.  So warm air over the sea rises while cool air flows in from the land to replace it, thus constituting a land breeze.  *Sea breeze:* his occurs during day.  Warm air rising  Sea breeze  Land (Hot)  Sea  During day the land is hotter than the sea.  The heated air over the land rises while cool air flows from the sea to replace it, thus constituting a sea breeze | ½  ½  1  ½  ½  1 |
| ***Total = 20*** | | | |