

ENMIN 5140 Materials Handling and Hoisting Course Question Sheet

- 1) A Shuttle car travels at an average velocity of 1.5 m/s from a loading machine to a conveyor belt where it will discharge its payload. If the travel time is 70 seconds, what will be the distance between the loading point and the dump?
- 2) If a surface haulage truck accelerates at a uniform rate of 0.2m/s^2 from rest, what will be its velocity after 25 seconds?
- 3) A 20 tonne mine locomotive is travelling at 45 km/hr. Determine the retarding force of the brakes required to stop it in 250m on a level track.
- 4) A mine utilises a 60 tonne locomotive. On clean dry rails the adhesion factor is 0.2 for braking. In these circumstances what is the tractive effort in kg?
- 5) For the locomotive in question 4, if the locomotive resistance is 14 kg/tonne determine the drawbar pull.
- 6) An open-pit copper mine uses one 19 m^3 loading shovel to load 170 tonne capacity haulage trucks. Usually it takes four passes with the shovel (cycle time: 40 s per pass) to load each truck. The average load per truck is 61.2 m^3 . The copper ore has a density of 2258 kg/m^3 (bank), and the ore has a swell factor of 0.67. The following times have been projected: haul time, 18 min; spot time, 0.5 min; dump time, 1.0 min; return time, 12 min. determine the production in tonnes per hour for each truck.
- 7) An evacuation hoist is to be installed for an underground coalmine. The vertical hoist will evacuate 5 miners at one time every 4 minutes. The depth of the overburden is 200 m. Determine if a 0.625 in 6 x 19- haulage rope would be adequate for this application? The following may be assumed, the escape capsule weighs 907.2 kg, the total weight of the miners is 680.3 kg and the maximum rope velocity is 1.524 m/s. For the rope the weight per m of rope is 0.1 kg/m, minimum factor of safety for man riding is 9, breaking strength is 11287 kg.
- 8) For a hoisting system with a 3 period Trapezoidal speed time diagram determine the hoisting capacity of a shaft if the skip payload is 22 tonnes, hoisting distance is 800m, maximum rope speed is 10 m/s, acceleration and deceleration are 1.5 m/s^2 and the rest time between winds is 10 s.
- 9) For the following winding conditions determine if a rope with a minimum breaking force of 10 MN gives a satisfactory factor of safety for the winding of ore?

Depth of wind = 850m

Mass of skip and attachments = 15 tonne

Mass of ore wound per wind = 22 tonne

Mass of rope/100m = 750 kg/100m

Note for ore hoisting using a drum winder minimum factor of safety = 7.0

- 10)** A 70 tonne locomotive is used to haul coal from a loading sidetrack to an unloading centre 2000m distant. The trips are designed to accelerate at a rate of 0.24 kphps on a level grade. If 10 tonne capacity cars with a tare weight of 5 tonnes are used. Determine the number of locomotives required to haul a shift tonnage of 7000 tonnes. It can be assumed that the locomotives average a speed of 16 kph with a 5 minute turnaround at each end. Roller bearings are used throughout and an adhesive factor of 25% is to be used. Operating time per shift is 8 hours.
- 11)** Determine the size of locomotive required to pull a 400 tonne train from a level siding at a maximum acceleration of 0.3 kphps if antifriction bearings with an $F = 0.1$ kg/tonne are used on all equipment. An adhesive factor of 25% should be used.
- 12)** For the locomotive in problem 11, determine the maximum grade against which the locomotive can pull the train without decelerating, using the same adhesive factor.
- 13)** For the situation in problem 12, if the adhesive factor is 35% what is the maximum grade the locomotive can pull the train without decelerating?
- 14)** Design a conveyor belt to haul mineral, density 1200 kg/loose m³, 1500 m on the level in an underground mine. Peak capacity is to be 2500 tonne/hr, belt speed is advised to be 4 m/s. Assume that the drive has automatic take-up, lagged pulley and a 270° arc of contact. Motor drive efficiency is 0.83.
- 15)** Design a conveyor belt for the same situation as problem 17, except the belt is hauling the coal up a 10° slope whose slope distance is 1507.5m.
- 16)** Two 5 tonne shuttle cars operate at an average speed of 2 m/s during the development phase of a panel. The loading machine has a rate of 2.5 tonnes/min. loader/ change out distance is 30m. If each shuttle car incurs a wait at the change out point of 0.5 min and the shuttle car discharge time is 0.45 min what is the haul distance from the change out point to the dumping point?
- 17)** Estimate the cycle time and production of a 72 tonne GVW off highway truck with 41 tonnes on its rear wheels when loaded to its rated capacity, operating on a level haul road of 1500m length. The road is a rutted dirt roadway with no maintenance and no stabilisation, tyre penetration is 3 cm. The following can be assumed;
 - a)** Loading time 1.4 min
 - b)** Manoeuvre and dump time 0.8 min
 - c)** Truck hauls 40 tonnes of ore each trip
 - d)** Job efficiency of 0.8
- 18)** For the situation in question 17, determine the cycle time if road conditions were improved to a rolling resistance of 20 kg/tonne.
- 19)** For the problem in question 18 the engineer at the site is considering the use of a shorter, 1000m, haul road that has a slope of 4% adverse. If all other factors remain the same which haul route should be selected on the basis of shortest cycle times? What are the cycle times and hourly productions?

- 20)** For a standard load haul dump situation drawing ore from an open stope and dumping to an ore pass, describe the factors that make up the cycle time for the unit. Also to achieve a desired production rate detail the method you would use to select the required bucket size and number of units to be used.
- 21)** What is the difference between a drum hoist winding system and a koepe winding system? What factors influence the application of each system?
- 22)** In a conveying system what is the impact of changing the troughing angle of the conveyor?.
- 23)** What guide arrangements can be employed in a shaft winding system and why are guiding systems required? Describe one method of guiding in greater detail.
- 24)** What type of unloading arrangements are there for skips in a shaft hoisting system?.
- 25)** What factors should be taken into account when selecting an excavator for an open pit mining operation?
- 26)** A shaft winding system is made up of a number of principal components, list each of these.
- 27)** Discuss the relative advantages and disadvantages of rubber tyred and tracked machinery for earthmoving.
- 28)** An off highway truck weighs 23 t empty and carts a payload of 35 t up a 6% grade. The RR factor is 50 kg/tonne. Calculate:
- The total resistance (kg)
 - The effective grade (%)
- 29)** a rubber tyred scraper unit weighing 50 t is towed by a crawler tractor weighing 40t up a 6% grade. The RR factor is 40kg/t. Calculate: a) The rolling resistance (kg)
- The grade resistance (kg)
 - The total resistance (kg)
- 30)** A Caterpillar D30D articulated dump truck has the rim pull curve in figure 1. (Gross weight 21.9 t empty, 49.117 t loaded). If the truck ascends a 7% grade with a rolling resistance of 40 kg/t, find the following: a) Total resistance (kg)
- The required rim pull (kg) when loaded
 - The maximum speed of the truck when loaded (km/h)

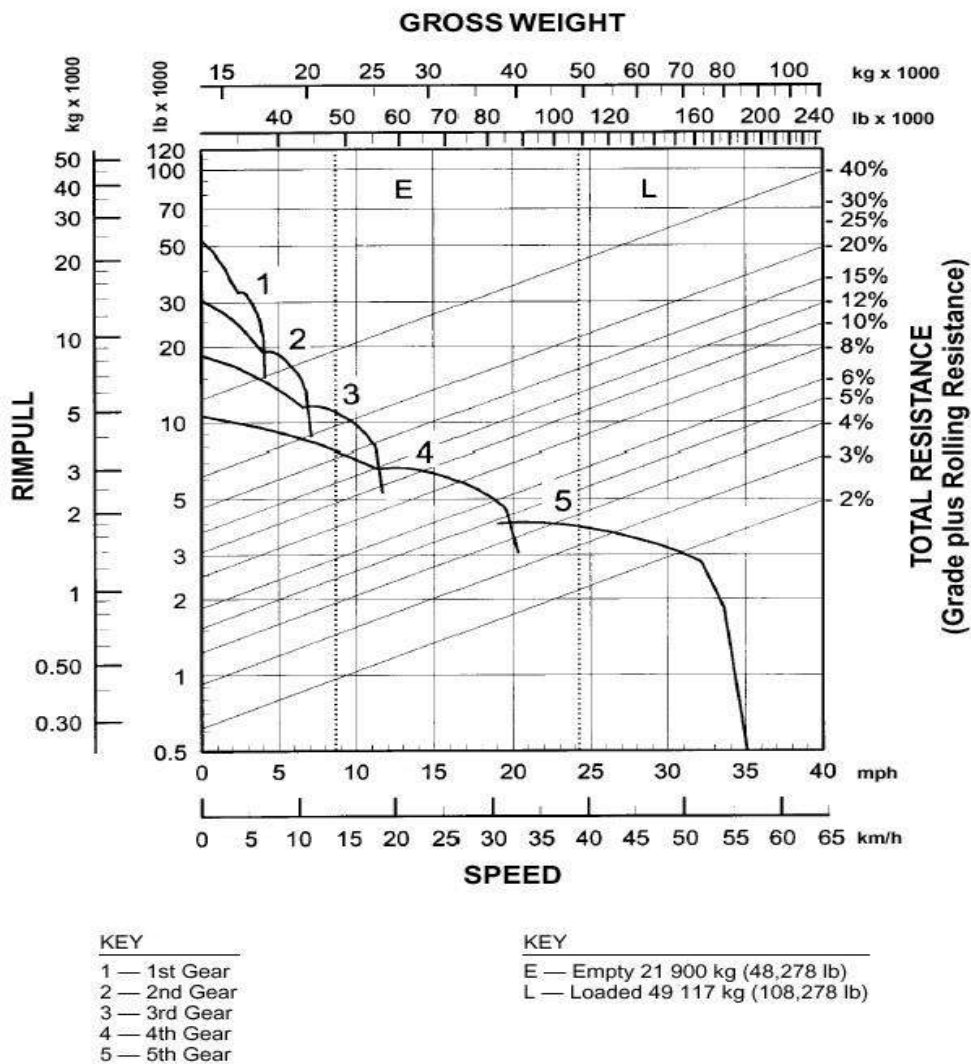


Figure 1: CAT D30D Rimpull, Speed, Gradeability (Caterpillar Performance Handbook version 31 (2000)).

31) The average speed of an 18m³ scraper is 30 km/hr and its return speed uphill is 22 km/hr over a 800 m haul distance and a 800m return distance. Using a fixed time of 5 minutes, calculate the cycle time (min).

32) A Caterpillar 631 E tractor scraper has the following characteristics:

Maximum heaped volume = 19.6 Bm³

Maximum payload = 34,000 kg

The material hauled is earth with a density of 1825 kg/Bm³

Rolling resistance is 30 kg/t and operating conditions are average with a job efficiency of 45 min/hour.

The haul route comprises of the following sections:

Section 1 (100m) level-loading zone

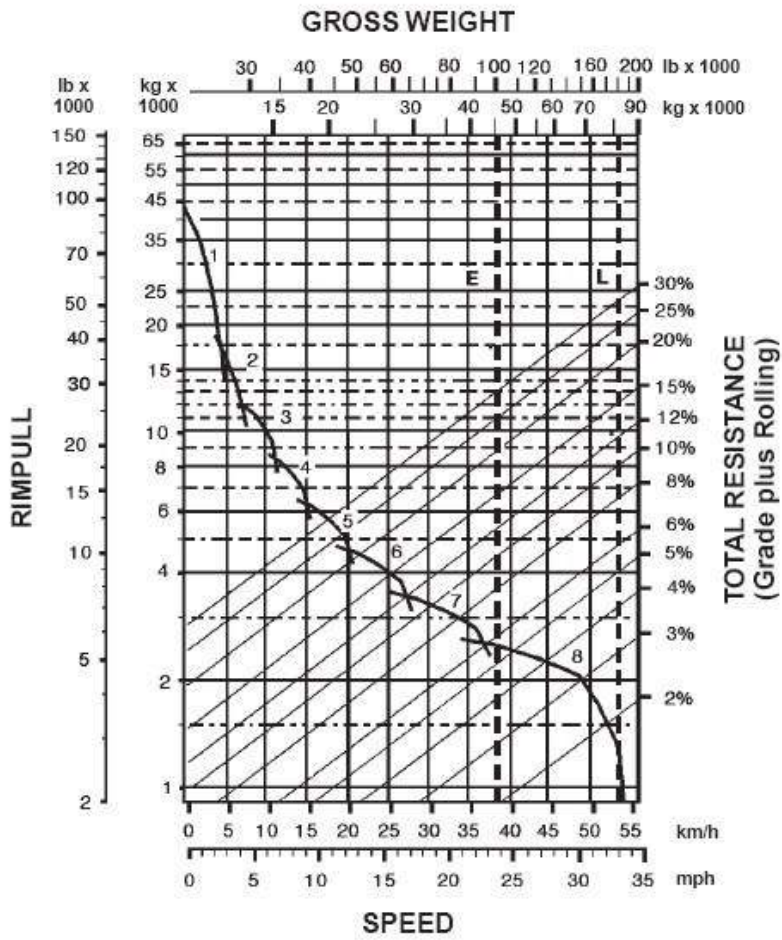
Section 2 (900m) 5% down grade

Section 3 (100m) level dumping zone Section

4 (900m) 5% up grade

Section 5 (80m) level turnaround area.

Estimate the machines production under these conditions using the travel time curves given in the following pages.



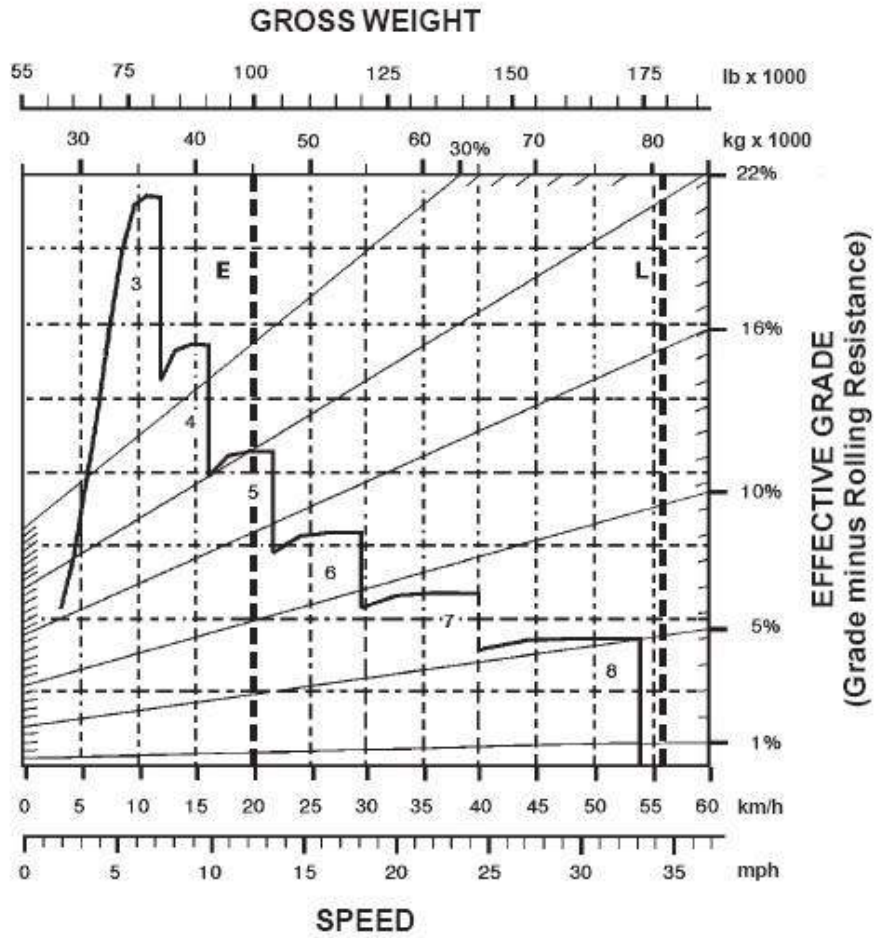
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KEY

1 — 1st Gear Torque Converter Drive
 2 — 2nd Gear Torque Converter Drive
 3 — 3rd Gear Direct Drive
 4 — 4th Gear Direct Drive
 5 — 5th Gear Direct Drive
 6 — 6th Gear Direct Drive
 7 — 7th Gear Direct Drive
 8 — 8th Gear Direct Drive

KEY

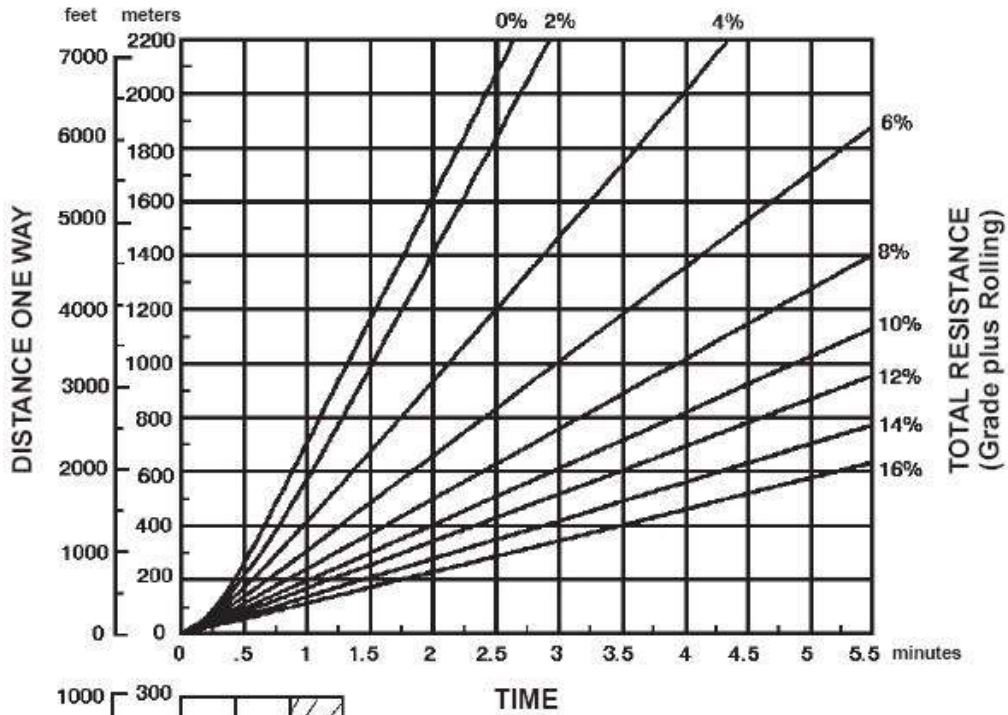
E — Empty 45 362 kg (100,006 lb)
 L — Loaded 82 647 kg (182,206 lb)



KEY
 3 — 3rd Gear Direct Drive
 4 — 4th Gear Direct Drive
 5 — 5th Gear Direct Drive
 6 — 6th Gear Direct Drive
 7 — 7th Gear Direct Drive
 8 — 8th Gear Direct Drive

KEY
 E — Empty 45 362 kg (100,006 lb)
 L — Loaded 82 647 kg (182,206 lb)

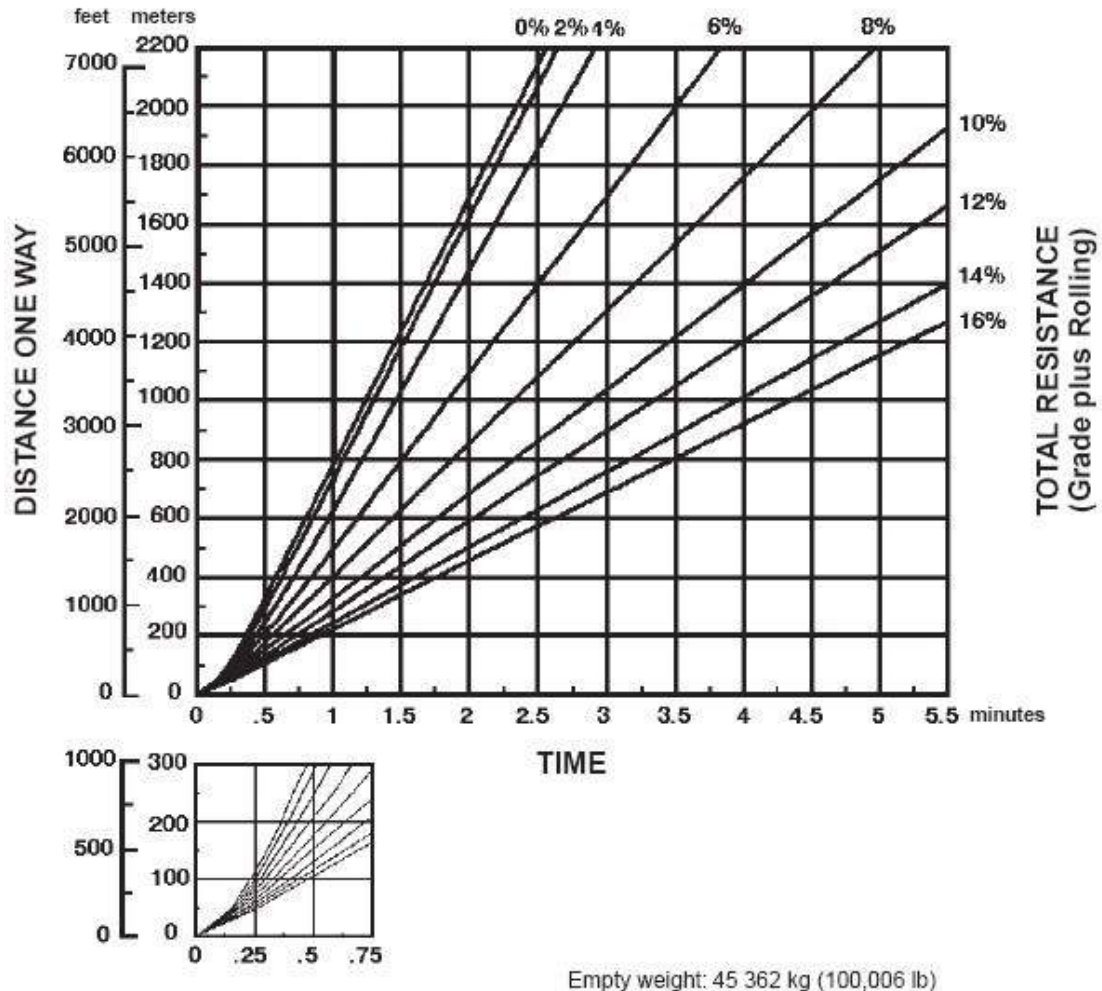
LOADED



8

Empty weight: 45 362 kg (100,006 lb)
 Payload: 37 285 kg (82,200 lb)

EMPTY



8-38

- 33) What is meant by line of site operation of automated equipment? What other methods are there to operate automated equipment?
- 34) An LHD has a bucket capacity of 4.5m³. The material being handled has a loose density of 2000 kg/m³ and the bucket fill factor is 0.9. Loading time including manoeuvring is 23 seconds and dump time is 12 seconds including manoeuvring. Acceleration and deceleration are equal at 0.3 m/s².

The one way haulage distance is 250m and the maximum speed of the unit is 2.5 m/s. Determine the following:

- a) The acceleration and deceleration times
- b) The acceleration and deceleration distances
- c) The maximum speed haulage distance (it can be assumed that the maximum speed is the same for the full and empty elements of the run)
- d) The fixed cycle time
- e) The variable cycle time
- f) The total cycle time
- g) If the machine has an availability of 50 minutes per hour how many cycles per hour can be achieved
- h) The productivity of the unit per hour

35)Detail the advantages and disadvantages of rail transport

36)Detail the advantages and disadvantages of conveyor transport

37)Define the following

- a. Swell factor
- b. Struck Capacity
- c. Heaped Capacity
- d. Fill Factor
- e. Rolling resistance
- f. Bank cubic metre
- g. Loose cubic metre
- h. Availability
- i. Operational availability
- j. Mechanical availability
- k. Physical availability
- l. Utilization
- m. Working efficiency
- n. Job efficiency
- o. Scheduled hours
- p. Annual hours
- q. Total hours
- r. Working hours
- s. Shift hours
- t. Operating hours

38.

- 1) .Design a double drum hoist for a 600m vertical shaft based on the following conditions:
 - a) Balanced operation
 - b) Weight of load = 5.75 ton (5.84 tonne)
 - c) Weight of skip = 8.25 ton (8.38 tonne)
 - d) Desired capacity = 400 tph (406.4 tonnes/hr)
 - e) Acceleration time = 10 s
 - f) Deceleration time = 10 s
 - g) Rest time per trip = 8 s
 - h) Efficiency = 0.85
 - i) An induction motor is to be used
 - j) A round strand rope is to be used.
- 2) For the system in question 1 what would be the rms HP for the hoist be if a self-ventilated dc motor were used?
- 3)
 - a) For a hoisting system with a 3 period Trapezoidal speed time diagram determine the hoisting capacity of a shaft if the skip payload is 25 tonnes, hoisting distance is 750m, maximum rope speed is 15 m/s, acceleration and deceleration are 1.5 m/s^2 and the rest time between winds is 10 s.
 - b) For the following winding conditions determine if a rope with a minimum breaking force of 6 MN gives a satisfactory factor of safety for the winding of ore?

Depth of wind = 850m

Mass of skip and attachments = 12 tonne Mass

of ore wound per wind = 25 tonne

Height of sheaves above skip top when skip unloading at shaft top = 20m

Mass of rope/100m = 750 kg/100m

Note for ore hoisting using a drum winder minimum factor of safety = 7.0

- c) If the maximum winding speed for the wind described in part (b) is 18 m/s and acceleration = deceleration = 2 m/s^2 (assume linear change of speed during acceleration and deceleration) determine:
 - Accelerating period
 - Decelerating period
 - Distance travelled by skip in accelerating period
 - Distance travelled by skip during decelerating period
 - Time travelling at maximum speed • Distance travelled at maximum speed.
 - Total cycle time assuming a 10 s rest period between winds
 - Number of cycles per hour
 - Capacity of the system per hour

Plot a speed-time graph for this situation.

- d) The system described in parts (b) and (c) are for an unbalanced hoisting system employing a drum winding system. Determine variation of the tractive force at the circumference of the drum and the total torque required at the drum to drive the system. Rope diameter is 50mm, minimum drum diameter = 100 x rope diameter, diameter of sheaves = 5 m. Skip hoisting system, so $k = 1.15$. Friction resistance between skip and guides, air resistance, bending resistance etc. = $k \times$ mass of loaded skip.
- e) Determine the variation of the power at the drive shaft for this system assuming a constant radius of coiling of the rope on the drum (hint do this for each element within the cycle and plot on a torque/power time graph)
- f) Determine the rms torque and power for this system.