University of Ballarat
School of Science, Information Technology and Engineering

ENMIN 5140 Materials Handling and Hoisting

Course Question Sheet

Worth (100%) of Unit Total Marks

Due Date 25 July 2014

Each question other than question 36 is worth 10 marks, Question 36 is worth 100 marks

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 75 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 0.5 m/s^2 from rest, what will be its velocity after 20 seconds?

3) A 20 tonne mine locomotive is travelling at 10 km/hr. Determine the retarding force of the brakes required to stop it in 34m on a level track.

4) A mine utilises a 50 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 seven 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 6 miners at one time every 4 minutes. The depth of the overburden is 167.64 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) A vertical hoist is to be designed to haul ore at a rate of 500 tonnes/hour, from a depth of 400m, at an average skip velocity of 6.1 m/s. Determine the required skip load in tonnes.

9) Design a double drum hoist for a 1500 ft (457.2 m) 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.

10) For the system in question 9 what would be the rms HP for the hoist be if a self ventilated dc motor were used?

11)

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 900m,

maximum rope speed is 10 m/s, acceleration and deceleration are 2 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 2 MN gives a satisfactory factor of safety for the winding of ore?

Depth of wind = 450m
Mass of skip and attachments = 7 tonne
Mass of ore wound per wind = 10 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 15 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 the total torque required at the drum to drive the system. Rope diameter is 50mm, minimum drum diameter = 80 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 x mass of loaded skip.

e) Determine the variation of the tractive force at the circumference of the drum and 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.

12) A 60 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 up a 2% 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 6500 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 6 hours.

13) Determine the size of locomotive required to pull a 400 tonne train from a level siding at a maximum acceleration of 0.4 kphps if antifriction bearings with an F = 0.1 kg/tonne are used on all equipment. An adhesive factor of 25% should be used.

14) For the locomotive in problem 13, determine the maximum grade against which the locomotive can pull the train without decelerating, using the same adhesive factor.

15) For the situation in problem 14, if the adhesive factor is 35% what is the maximum grade the locomotive can pull the train without decelerating?

16) Design a conveyor belt to haul coal , density 1900 kg/loose m^3, 1500 m on the level in an underground mine. Peak capacity is to be 2500 tonne/hr, belt speed is advised to be 3 m/s. Assume that the drive has automatic take-up, lagged pulley and a 270° arc of contact. Motor drive efficiency is 0.83.

17) Design a conveyor belt for the same situation as problem 16, except the belt is hauling the coal up a 10° slope.

18) Two 5 tonne shuttle cars operate at an average speed of 1.5 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?

19) 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 2000m length. The road is a rutted dirt roadway with no maintenance and no stabilisation, tyre penetration is 12.5 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

20) For the situation in question 19, determine the cycle time if road conditions were improved to a rolling resistance of 30 kg/tonne.

21) For the problem in question 20 the engineer at the site is considering the use of a shorter, 1000m, haul road that has a slope of 6% 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?

22) 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.

23) What is the difference between a drum hoist winding system and a koepe winding system? What factors influence the application of each system?

24) Describe in detail one method of arresting a cage in an emergency situation in a shaft.

25) 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.

26) Detail the main components of a belt conveyor system. With respect to such systems what is meant by the terms transfer point and tandem operation.

27) What factors should be taken into account when selecting a shovel for an open pit mining operation?

28) A shaft winding system is made up of a number of principal components, list each of these.

29) Discuss the relative advantages and disadvantages of rubber tyred and tracked machinery for earthmoving.

30) An off highway truck weighs 23 t empty and carts a payload of 35 t up an 8% grade. The RR factor is 40 kg/tonne. Calculate:

   a) The total resistance (kg)
   b) The effective grade (%)

31) a rubber tyred scraper unit weighing 50 t is towed by a crawler tractor weighing 40t up a 4% grade. The RR factor is 50kg/t. Calculate:
   a) The rolling resistance (kg)
   b) The grade resistance (kg)
   c) The total resistance (kg)

32) 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 5% grade with a rolling resistance of 50kg/t, find the following:
   a) Total resistance (kg)
   b) The required rim pull (kg) when loaded
   c) The maximum speed of the truck when loaded (km/h)

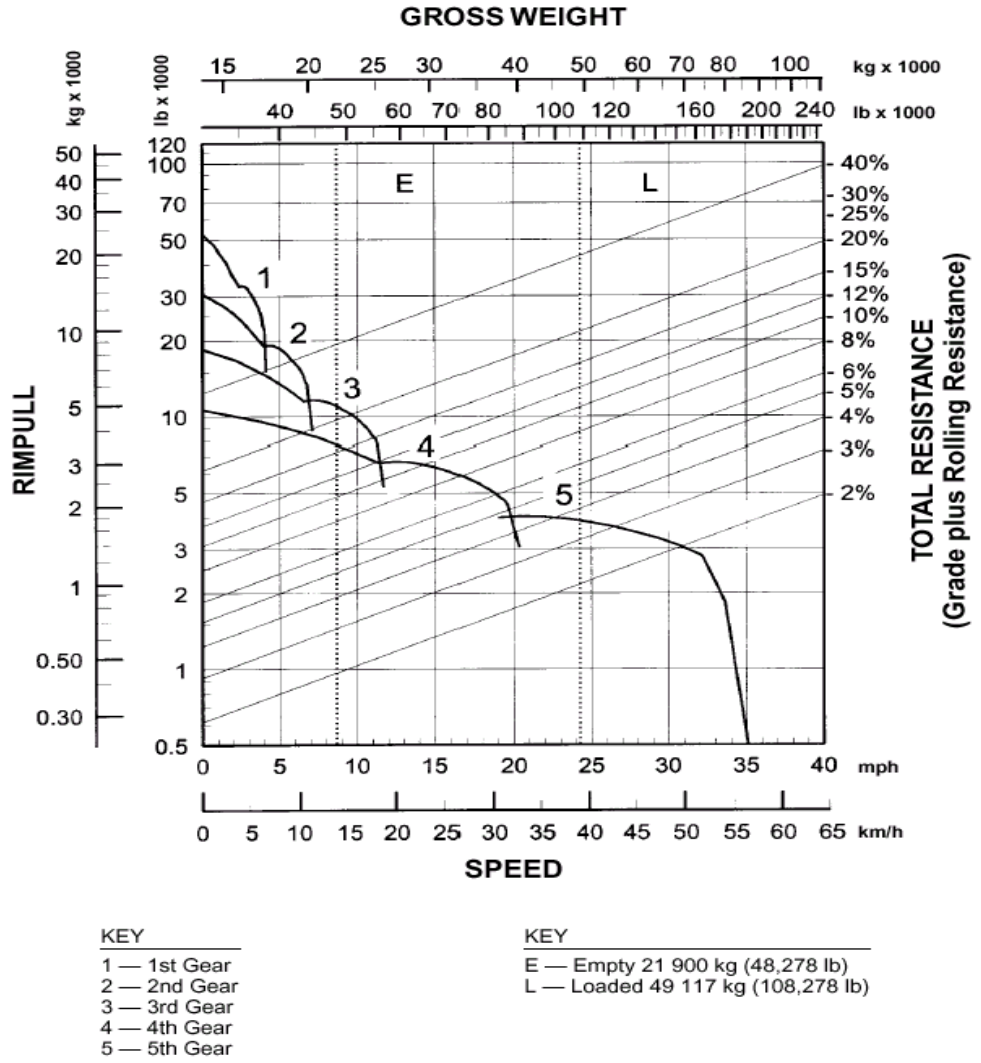


Figure 1: CAT D30D Rimpull, Speed, Gradeability (Caterpillar Performance Handbook version 31 (2000)).

33) The average speed of an 18m^3 scraper is 40 km/hr and its return speed uphill is 22 km/hr over a 400 m haul distance and a 450m return distance. Using a fixed time of 5 minutes, calculate the cycle time (min).

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

Maximum heaped volume = 19.6 Bm^3
Maximum payload = 34,000 kg
The material hauled is earth with a density of 1825 kg/Bm^3

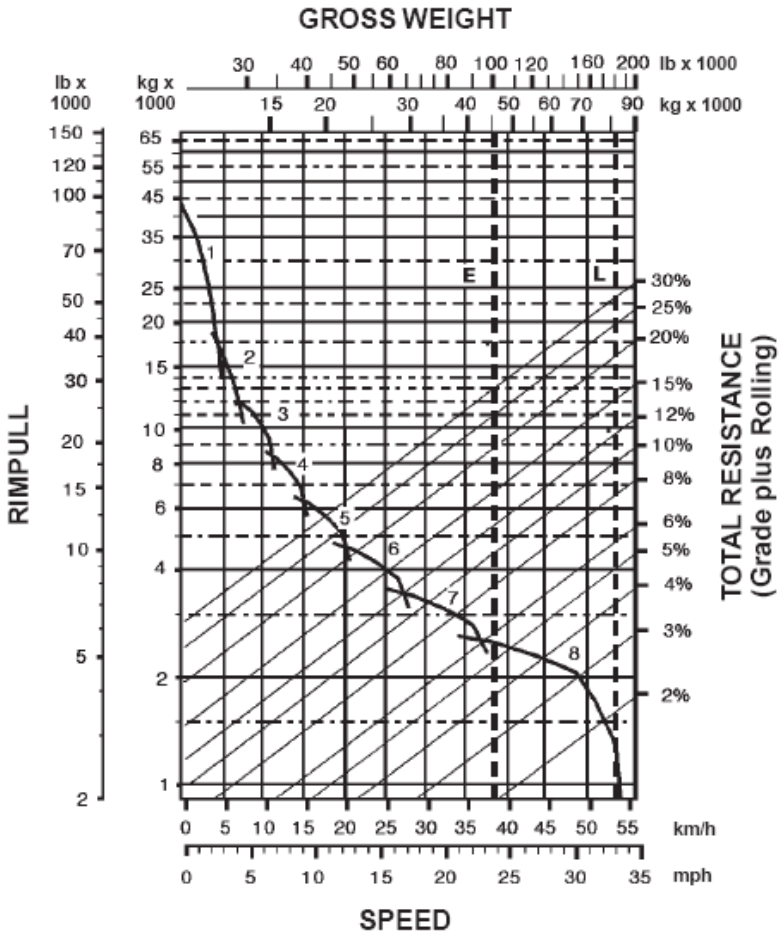
Rolling resistance is 30 kg/t and operating conditions are average with a job efficiency of 50 min/hour.

The haul route comprises of the following sections:

Section 1 (100m) level-loading zone

Section 2 (800m) 5% down grade
Section 3 (100m) level dumping zone
Section 4 (1km) 6% 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.



KEY

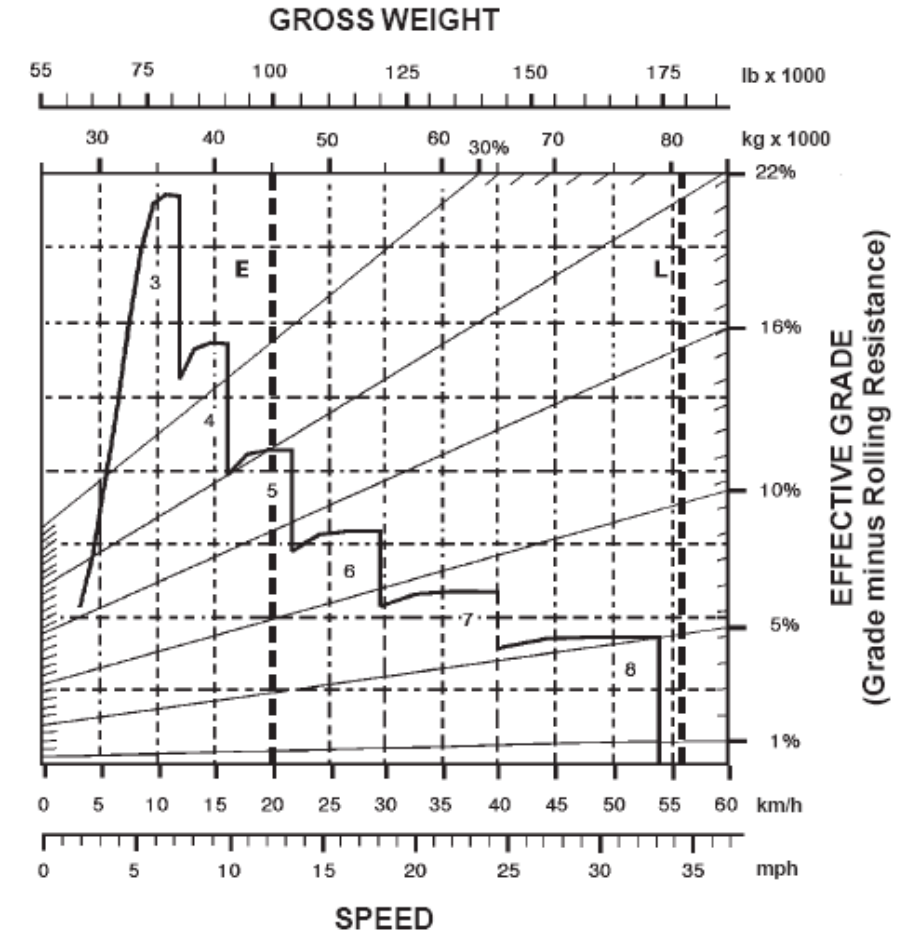
1 — 1st Gear Torque Converter Drive
2 — 2nd Gear Torque Converter Drive
3 — 3rd Gear Direct Drive
4 — 4th Gear Direct Drive
5 — 5th Gear Direct Drive
6 — 6th Gear Direct Drive
7 — 7th Gear Direct Drive
8 — 8th Gear Direct Drive

KEY

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

8

8-35



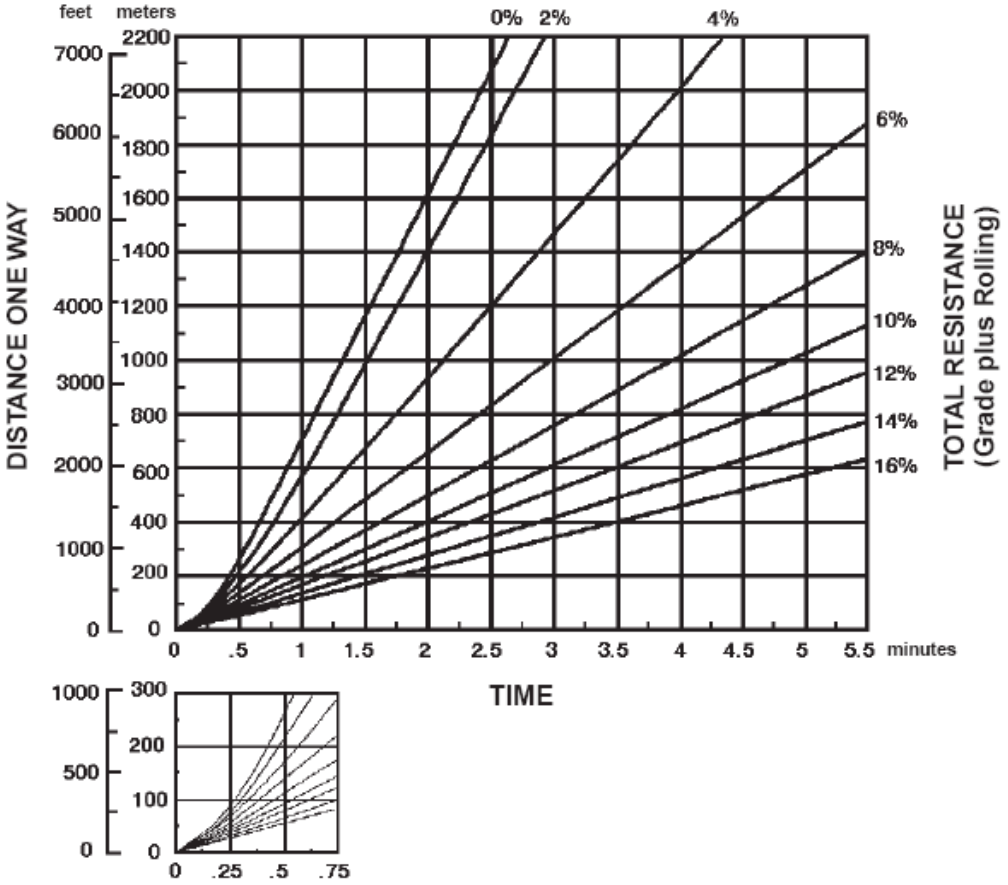
KEY

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

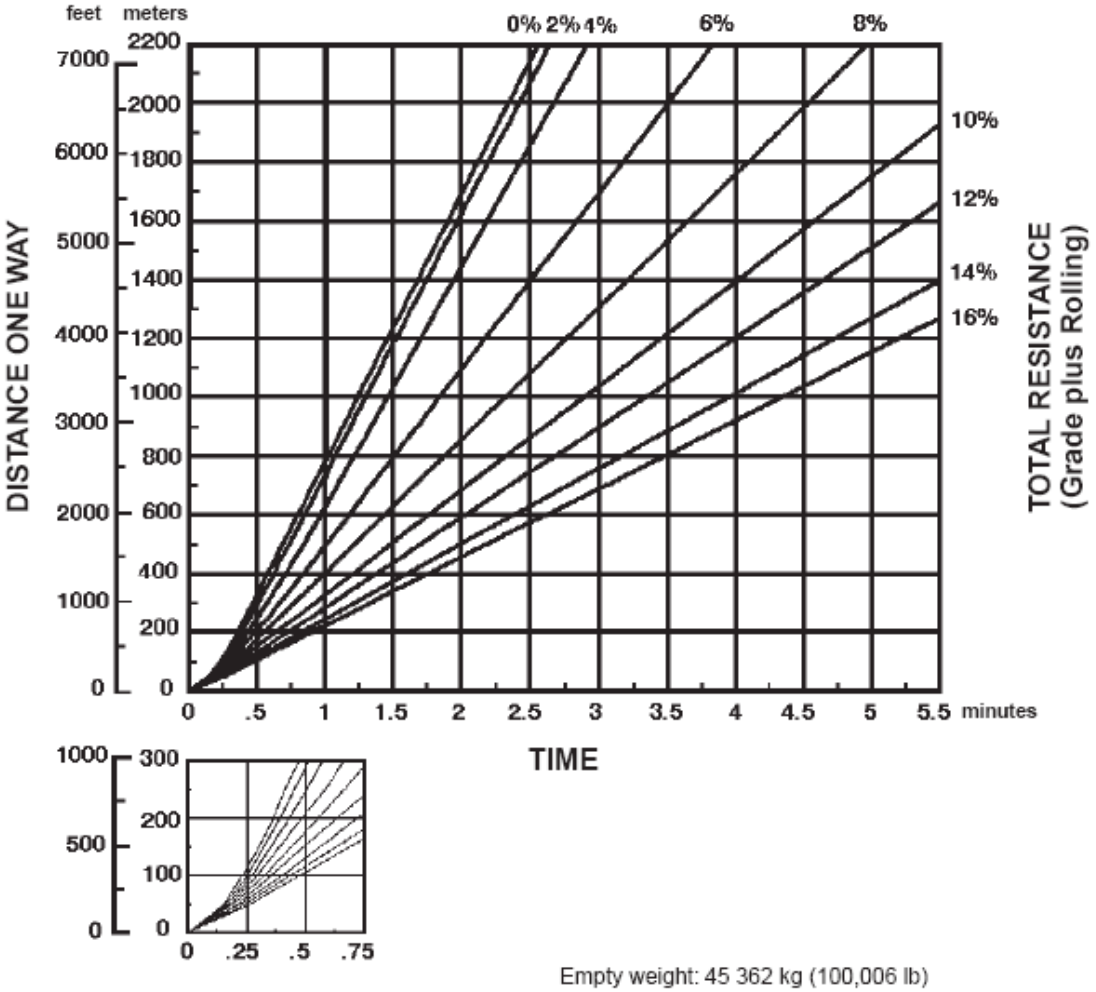


Empty weight: 45 362 kg (100,006 lb)
Payload: 37 285 kg (82,200 lb)

8

Wheel Tractor-Scrapers | 631G Travel Time — Empty
● 37.25R35 Tires

EMPTY



Empty weight: 45 362 kg (100,006 lb)

8-38

35) What is meant by line of sight operation of automated equipment?

36) Students are to write a brief report on the ore loading and materials handling systems employed at the mine at which they are employed or at a mine site that they can gain the information for. The report should include the following elements:

- Mine location
- Mining method
- Ore loading and transportation systems

- Alternative systems investigated or proposed
- Cycle times
- Future developments

The expectation is a brief report (which can be backed by further information provided as appendices) not exceeding 30 pages in length. The report should be referenced in an appropriate style and must include an executive summary no greater than two pages in length.