

# Arithmetic

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- 1** The acceleration due to gravity is denoted as  $1g$ , which is equal to  $9.807 \text{ m/s}^2$ . In a car accident a deceleration of  $27g$  will normally prove fatal to a passenger who weighs  $65 \text{ kg}$ . What is the magnitude of the force that this represents?

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- 2** A heavy current electrical component manufacturer has a policy of employing manual workers at  $55\%$  above the statutory minimum wage level. The company has to cater for a  $23\%$  on-cost above the amount paid to a worker and the company employs  $13$  manual workers. What is the percentage increase in the wage bill if the statutory minimum wage is increased by  $5\%$  and the on-cost increases by  $1\%$ ?

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- 3** A mechanical engineering company used to buy sheet steel to manufacture items that are designed according to imperial specification and found that sheets of steel that are eight feet by four feet were more suited than sheets that are six feet by three feet. The sheet steel supplier sells sheets in metric measure  $2500\text{mm}$  by  $1250\text{mm}$  ( $2.54\text{cm} = 1 \text{ inch}$ ). What is the percentage excess of the metric sheets over the imperial sheets?

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- 4** An industrial farm has two small experimental fields of  $24$  and  $28$  hectares respectively. A given experiment requires that the two fields are to be divided into a number of equal sized plots as large as possible. How many plots will there be and what size will they be?

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- 5** On a construction site three pile drivers begin to hammer together and they each continue to hammer at intervals of  $30$ ,  $40$  and  $45$  seconds respectively. When will they next all hammer together again?

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- 6** A machine can pack a given number of screws from a given consignment into boxes 4 at a time, 6 at a time or 9 at a time and end up with no screws left over. If the machine is set to pack the screws 7 at a time there are 4 screws left over. What is the smallest number of screws possible in the consignment?

Solutions

Working

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- 7** In a computer display each of three identical circles of 180mm in circumference has a dot that is travelling round the circumference. In circle A the dot travels at 10mm per second, in circle B it travels at 6mm per second and in circle C it travels at 4mm per second. If they all start at the same time from the top of each circle how long will it be before they are all simultaneously back at the tops of their respective circles?

Solutions

Working

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- 8** A company split a bonus payment of 792 shares between five employees. It gave  $\frac{5}{12}$  to two of them, a half of the remainder to a third employee and the rest were split in the ratio of 3 : 8 to the fourth and fifth employees. How many shares did the fourth and fifth employees each receive?

Solutions

Working

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- 9** In a textile dye-house a dye tank can be filled with cold water by one tap in 3 hours, by a second in 5 hours and by a third in 6 hours. How long will take to fill if all three taps are running?

Solutions

Working

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- 10** A manufacturer buys  $0.1875$  of an adjoining plot of land for development. He resells  $0.1\bar{7}$  of his purchase. What fraction remains of:
- (a) His purchase?
  - (b) The original plot of land?

Solutions

Working

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**11** Temperatures of 0 degrees and 100 degrees Celsius ( $^{\circ}\text{C}$ ) correspond with temperatures 32 degrees and 212 degrees Fahrenheit ( $^{\circ}\text{F}$ ), respectively, and temperatures 0 degrees and 80 degrees Réaumur ( $^{\circ}\text{R}$ ), respectively. Convert the following values to Fahrenheit:

- (a) Iron melts at  $1805^{\circ}\text{C}$
- (b) Gold melts at  $1520^{\circ}\text{C}$
- (c) Copper melts at  $1090^{\circ}\text{C}$
- (d) Silver melts at  $1052^{\circ}\text{C}$
- (e) Tin melts at  $230^{\circ}\text{C}$
- (f) Water boils at  $80^{\circ}\text{R}$
- (g) Sodium melts at  $72^{\circ}\text{R}$
- (h) Ammonia boils at  $48^{\circ}\text{R}$
- (i) Bismuth melts at  $196^{\circ}\text{R}$

[Solutions](#)

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**12** An oil tanker sails at the rate of 12 knots (nautical miles per hour). If a nautical mile is 1.15 statute miles how long will take the ship to complete a 1700 statute mile voyage?

[Solutions](#)

[Working](#)

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**13** A publisher's printer produces 3500 sheets of paper per hour. If the speed of printing is decreased in the ratio 7 : 4 how many sheets will be printed in 12 hours?

[Solutions](#)

[Working](#)

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## Solutions

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**1** 17,211 Newtons to 5 sig fig.

[Questions](#)

[Working](#)

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**2** 5.9% increase to 1 dp.

[Questions](#)

[Working](#)

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**3** 5.1% to 1 dp

[Questions](#)

[Working](#)

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**4** 13 plots in total, each of size 4 hectares

[Questions](#)

[Working](#)

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**5** After 360 seconds have elapsed.

[Questions](#)

[Working](#)

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**6** 144

Questions

Working

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**7** 90 seconds

Questions

Working

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**8** 18 and 48 shares

Questions

Working

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**9**  $\frac{10}{7} = 1\frac{3}{7}$  hours

Questions

Working

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**10** (a)  $\frac{37}{45} = 0.82$   
(b)  $\frac{29}{30} = 0.96$

Questions

Working

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**11** (a) 3281°F (f) 212°F  
(b) 2768°F (g) 194°F  
(c) 2003°F (h) 140°F  
(d) 1925.6°F (i) 473°F  
(e) 446°F

Questions

Working

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**12** 5.13 days to 2 dp

Questions

Working

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**13** 24,000

Questions

Working

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## Working

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**1** The force is given by Newton's law  $Force = Mass \times Acceleration$  where the mass is 65 kg and the acceleration is  $-27g$  – negative because it is a deceleration. Hence:

$$Force = (65)(-27)(9.807) = -17,211 \text{ to 5 sig fig}$$

So the magnitude of the force is 17,211 Newtons.

Questions

Solutions

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**2** Let the statutory minimum wage be  $x$  per hour so the company pays  $1.55x$  per hour. With the 23% on-cost this amounts to  $1.23 \times 1.55x$  per hour cost to the employer.

If the statutory minimum wage is increased by 5% it becomes  $1.05x$  per hour so the employee is then paid  $1.55 \times 1.05x$  per hour which, with a 1% increase in on-costs to 24%, amounts to a  $1.24 \times 1.55 \times 1.05x$  per hour cost to the employer.

$1.24 \times 1.55 \times 1.05x$  represents a percentage increase over  $1.23 \times 1.55x$  per hour of:

$$\frac{1.24 \times 1.55 \times 1.05x - 1.23 \times 1.55x}{1.23 \times 1.55x} = \frac{1.24 \times 1.05 - 1.23}{1.23} \\ = 5.9 \text{ increase to 1 dp}$$

Questions

Solutions

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**3** There are 12 inches to the foot so 2500 mm is equal to  $\frac{2500}{25.4 \times 12} = 8.20$  feet to 2 dp and 1250 mm is equal to half that, namely 4.10 feet to 2 dp. The area of the 2500 mm by 1250 mm sheet is:

$$8.20 \times 4.10 = 33.62 \text{ square feet}$$

This represents an excess of 1.62 square feet over the original eight feet by four feet sheets. The percentage excess is then:

$$\frac{1.62}{32} \times 100 = 5.1\% \text{ to 1 dp}$$

Questions

Solutions

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**4** The factors of 24 are 1, 2, 3, 4, 6, 8, 12 and 24  
The factors of 28 are 1, 2, 4, 7, 14, 28

The highest common factor is 4 and so this is the size of the largest plot in hectares. So there are 6 plots in the field of 24 hectares and 7 plots in the field of 28 hectares – 13 in all.

Questions

Solutions

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**5** The pile drivers will hammer together after the lowest common multiple of their intervals has elapsed. Now,

$$30 = 2 \times 3 \times 5, \quad 40 = 2 \times 2 \times 2 \times 5 \quad \text{and} \quad 45 = 3 \times 3 \times 5$$

so the LCM is  $2 \times 2 \times 2 \times 3 \times 3 \times 5 = 360$  seconds.

Questions

Solutions

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- 6** Because the machine can pack a given number of screws into boxes 4 at a time, 6 at a time or 9 at a time and end up with no screws left over, each consignment must contain a multiple of the lowest common multiple of 4, 6 and 9 which is 36 screws. Now, 7 divides into 36 five times with 1 remaining so it will divide into  $4 \times 36 = 144$  twenty times with 4 remaining.

Questions

Solutions

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- 7** Dot A takes  $180/10 = 18$  seconds to travel round circle A, dot B takes  $180/6 = 30$  seconds to travel round circle B and dot C takes  $180/4 = 45$  seconds to travel round circle C. The dots will arrive at the tops of their respective circles together again after the lowest common multiple of their time intervals has elapsed. Now,

$$18 = 2 \times 3 \times 3, \quad 30 = 2 \times 3 \times 5 \quad \text{and} \quad 45 = 3 \times 3 \times 5$$

so the LCM is  $2 \times 3 \times 3 \times 5 = 90$  seconds.

Questions

Solutions

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- 8**  $5/12$  to two of the employees equals  $10/12$  and  $10/12 \times 792 = 660$ . This leaves 132 of which one half – 66 – was split in the ratio 3 : 8, that is  $3/11$  and  $8/11$  between the fourth and fifth employees. Now  $3/11$  of  $66 = 18$  and  $8/11$  of  $66 = 48$  so the fourth and fifth employees received 18 and 48 shares.

Questions

Solutions

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- 9** In one hour one tap will fill  $1/3$  of the tank, a second tap will fill  $1/5$  of the tank and the third tap will fill  $1/6$  of the tank. So, running together all three taps will fill:

$$\frac{1}{3} + \frac{1}{5} + \frac{1}{6} = \frac{21}{30} \text{ of the tank in 1 hour.}$$

Therefore if  $21/30$  of the tank is filled in 1 hour the entire tank will be filled in  $30/21 = 10/7$  hours.

Questions

Solutions

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**10**

(a)  $0.1875 = \frac{3}{16}$  so he has purchased  $\frac{3}{16}$  of the original plot of land. He has sold  $0.1\dot{7} = \frac{8}{45}$  of his purchase so  $\frac{37}{45} = 0.82$  of it remains.

(b) Of the original plot of land he has sold off

$$\frac{8}{45} \text{ of } \frac{3}{16} = \frac{8}{45} \times \frac{3}{16} = \frac{1}{30}$$

leaving  $\frac{29}{30}$  remaining.

Questions

Solutions

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**11**

$100^{\circ}\text{C}$  is equivalent to  $180^{\circ}\text{F}$  so  $1^{\circ}\text{C}$  is equivalent to  $1.8^{\circ}\text{F} = 9/5^{\circ}\text{F}$ . So to convert Celsius to Fahrenheit we start at  $32^{\circ}\text{F}$  because this is equivalent to  $0^{\circ}\text{C}$  and add on  $(9/5) \times$  the number of degrees Celsius. That is:

$$\text{degrees F} = 32 + (9/5) \text{ degrees C}$$

Also,  $80^{\circ}\text{R}$  is equivalent to  $180^{\circ}\text{F}$  so  $1^{\circ}\text{R}$  is equivalent to  $9/4^{\circ}\text{F}$ . So to convert Réaumur to Fahrenheit we start at  $32^{\circ}\text{F}$  because this is equivalent to  $0^{\circ}\text{R}$  and add on  $(9/4) \times$  the number of degrees Réaumur. That is:

$$\text{degrees F} = 32 + (9/4) \text{ degrees R}$$

Therefore:

- (a) Iron melts at  $1805^{\circ}\text{C} = (32 + [9/5] \times 1805)^{\circ}\text{F} = 3281^{\circ}\text{F}$
- (b) Gold melts at  $1520^{\circ}\text{C} = (32 + [9/5] \times 1520)^{\circ}\text{F} = 2768^{\circ}\text{F}$
- (c) Copper melts at  $1090^{\circ}\text{C} = (32 + [9/5] \times 1090)^{\circ}\text{F} = 1994^{\circ}\text{F}$
- (d) Silver melts at  $1052^{\circ}\text{C} = (32 + [9/5] \times 1052)^{\circ}\text{F} = 1925.6^{\circ}\text{F}$
- (e) Tin melts at  $230^{\circ}\text{C} = (32 + [9/5] \times 230)^{\circ}\text{F} = 446^{\circ}\text{F}$
- (f) Water boils at  $80^{\circ}\text{R} = (32 + [9/4] \times 80)^{\circ}\text{F} = 212^{\circ}\text{F}$
- (g) Sodium melts at  $72^{\circ}\text{R} = (32 + [9/4] \times 72)^{\circ}\text{F} = 194^{\circ}\text{F}$
- (h) Ammonia boils at  $48^{\circ}\text{R} = (32 + [9/4] \times 48)^{\circ}\text{F} = 140^{\circ}\text{F}$
- (i) Bismuth melts at  $196^{\circ}\text{R} = (32 + [9/4] \times 196)^{\circ}\text{F} = 473^{\circ}\text{F}$

Questions

Solutions

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**12**

1700 equals  $1700/1.15 = 1478.26$  nautical miles to 2 dp. Travelling at 12 knots the journey will take  $1478.26/12 = 123.19$  hours = 5.13 days to 2 dp.

Questions

Solutions

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**13**

The printing is decreased from 3500 sheets per hour to  $(4/7) \times 3500 = 2000$  sheets per hour. In 12 hours the printer will then print 24,000 sheets.

Questions

Solutions

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