19 A sailboat is pushed by the wind at a constant velocity *v* across a lake.

The force of the wind and the velocity of the sailboat are in the same direction.

Which additional information is required to determine the work done per unit time by the wind acting on the sailboat?

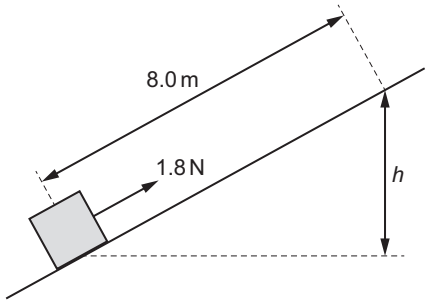
A the force exerted by the wind

B the distance travelled by the sailboat per unit time

C the total energy input to the sailboat by the wind

D the weight of the sailboat

19 The diagram shows a block on a slope.



A constant force of 1.8 N in a direction parallel to the slope is exerted on the block. This causes the block to move along the slope at a constant speed.

The block moves a distance of 8.0 m along the slope and gains height *h*. The work done against the frictional force acting on the block is 4.8 J.

The weight of the block is 4.0 N.

What is the value of *h*?

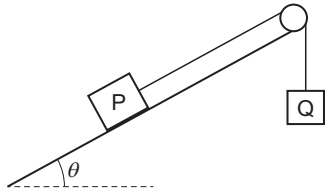
A 1.2 m **B** 2.4 m **C** 3.6 m **D** 4.8 m

20 The motor of a crane lifts a load of mass 600 kg. The load rises vertically at a constant speed of 12 m per minute.

What is the useful power output of the motor?

A 0.12 kW **B** 1.2 kW **C** 7.2 kW **D** 71 kW

16 The diagram shows a block P of mass *M* connected by a string over a frictionless pulley to a block Q of mass *m*.



Block P moves up the slope with a constant velocity *v*. The slope is at angle θ to the horizontal.

The acceleration of free fall is *g*.

The resistive forces on the blocks are negligible.

Which expressions give the energy transferred per unit time to block P?

1 mgv

2 $Mgv\sin\theta$

3 $(M + m)gv$

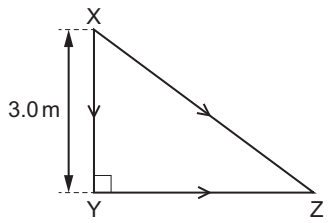
A 1 and 2 **B** 1 only **C** 2 and 3 **D** 2 only

18 The total energy supplied to an electric motor is *E*. Energy *Q* is wasted and the remaining energy does useful work.

What is the efficiency of the motor?

A $\frac{Q}{E}$ **B** $\left(\frac{Q}{E}\right) - 1$ **C** $1 - \left(\frac{Q}{E}\right)$ **D** $\frac{(1-Q)}{E}$

18 The points X, Y and Z are on a rough, horizontal surface.



A box P is pushed across the surface from X to Y and then from Y to Z.

The distance from X to Y is 3.0 m. The work done against the frictional force in moving the box from X to Y is 150 J.

The work done against the frictional force in moving the box from Y to Z is 200 J.

An identical box Q is pushed in a straight line from X to Z.

The magnitude of the frictional force between the boxes and the surface is constant.

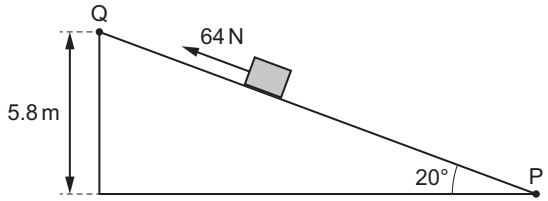
How much extra work is done against the frictional force in moving P than Q?

A 100 J **B** 250 J **C** 350 J **D** 600 J

19 A box of mass 4.9 kg is pushed at a constant velocity from point P at the bottom of an inclined plane to point Q at the top.

The box is pushed by a force of 64 N acting parallel to the slope.

The slope is inclined at an angle of 20° to the horizontal and the box moves through a vertical height of 5.8 m.



What is the work done against the frictional force acting on the block between P and Q?

A 280 J **B** 810 J **C** 960 J **D** 1100 J

20 Which expression gives the efficiency of a system?

A $\frac{\text{total energy input}}{\text{useful energy output}}$

B $\frac{\text{useful energy output + wasted energy output}}{\text{total energy input}}$

C $\frac{\text{useful energy output}}{\text{total energy input}}$

D $\frac{\text{wasted energy output}}{\text{total energy input}}$

17 An electric motor uses 1.7 kW of power when operating normally.

The efficiency of the motor is 53%.

What is the useful output power of the motor?

A 0.032 kW **B** 0.90 kW **C** 3.2 kW **D** 90 kW

14 In which situation is work done on an object?

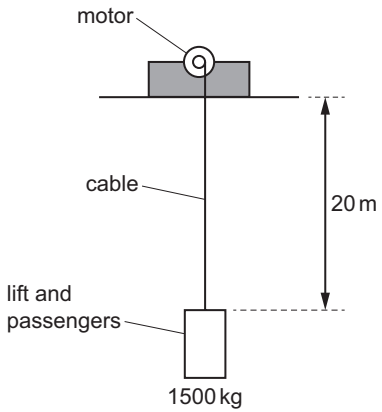
A The object slides with a constant velocity along a horizontal frictionless surface in a vacuum.

B A person holds the object at arm's length and at a fixed height above the ground.

C A person pushes the object up a frictionless ramp.

D The stationary object floats partially submerged in water.

15 An electric motor operating a lift has an output power of 20 kW.



The lift and passengers have a combined mass of 1500 kg. The motor raises the lift at constant speed through a distance of 20 m.

How long does it take?

A 6 s **B** 15 s **C** 30 s **D** 60 s

3 **(a)** State what is meant by the work done by a force.

.....

..... [1]

(b) A block of mass m is raised vertically at constant speed. The vertical height gained by the block is Δh, as shown in Fig. 3.1.

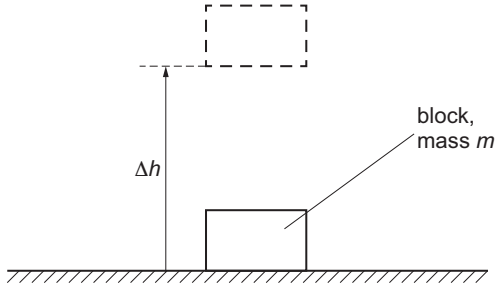


Fig. 3.1

Derive an expression, in terms of m and Δh, for the change in gravitational potential energy ΔE_P of the block. State the meaning of any other symbols you use.

[2]

(c) An electric motor has an input power of 900 W. The motor takes 1.0 minute to lift a load of weight 240 N at constant speed through a vertical height of 150 m. Resistive forces are negligible.

(i) Show that the work done by the motor on the load in 1.0 minute is 36 kJ.

[1]

(ii) Determine the useful output power of the motor.

power = ... W [2]

(iii) Use your answer in **(c)(ii)** to determine the efficiency of the motor.

efficiency = ... [2]

(iv) Some of the power wasted in the motor is dissipated by the resistance of its coil. This dissipated power is 280 W.

The coil of the motor is made from wire of total length 23 m. The wire has a cross-sectional area of $2.6 \times 10^{-8}\,m^2$ and is made from metal of resistivity $1.7 \times 10^{-8}\,\Omega m$.

Calculate the current in the coil.

current = ...A [3]

[Total: 11]