Question 19 (Answer: **A**)

- Work per unit time is power, and for a force along the motion $P = Fv$.
- The speed v is already given in the question, so the only missing quantity is the force.
- B just restates the speed, and C and D are not needed at all.

Question 19 (Answer: **B**)

- The applied force does $1.8 \times 8.0 = 14.4$ J of work.
- At constant speed that all goes to friction and to lifting the block: $14.4 = 4.8 + 4.0h$.
- So $h = 9.6/4.0 = 2.4$ m.

Question 20 (Answer: **B**)

- Convert the speed: 12 m per minute is $12/60 = 0.20$ m s^{-1}.
- At constant speed the useful force equals the weight, so $P = mgv$.
- $P = 600 \times 9.81 \times 0.20 = 1180$ W, about 1.2 kW.

Question 16 (Answer: **A**)

- Q descends at speed v, so it releases energy at a rate mgv – statement 1.
- P rises a vertical height $v \sin\theta$ each second, gaining potential energy at $Mgv \sin\theta$ – statement 2.
- At constant speed with no friction $mg = Mg \sin\theta$, so the two expressions are equal and both are right.

Question 18 (Answer: **C**)

- The useful energy is what is left after the waste: $E - Q$.
- Efficiency is useful over total, so it is $(E - Q)/E$.
- That simplifies to $1 - Q/E$.

Question 18 (Answer: **A**)

- Friction is $150/3.0 = 50$ N, so the 200 J from Y to Z means YZ = 4.0 m.
- X, Y and Z form a 3–4–5 right-angled triangle, so the direct path XZ is 5.0 m.
- P travels 7.0 m and Q only 5.0 m, so the extra work is $50 \times 2.0 = 100$ J.

Question 19 (Answer: **B**)

- The distance along the slope is $5.8/\sin 20° = 17.0$ m.
- The pushing force does $64 \times 17.0 = 1085$ J of work.
- At constant speed the rest goes to friction: $1085 - (4.9 \times 9.81 \times 5.8) = 810$ J.

Question 20 (Answer: **C**)

- Efficiency is useful output energy divided by total input energy.
- A is upside down and would give a value greater than one.
- D uses the wasted output, which is the fraction lost rather than the efficiency.

Question 17 (Answer: **B**)

- Useful output power is the efficiency multiplied by the input power.
- $0.53 \times 1.7 = 0.90$ kW.
- C divides by the efficiency instead of multiplying, which would make the motor a source of energy.

Question 14 (Answer: **C**)

- Work is done only when a force has a component along the movement.
- Pushing the object up the ramp moves it in the direction of the push, so work is done on it.
- A has no force, B has no movement, and D is stationary – none does work.

Question 15 (Answer: **B**)

- The useful work is the gain in gravitational potential energy: $1500 \times 9.81 \times 20 = 2.94 \times 10^5$ J.
- Time is work divided by power: $2.94 \times 10^5 / 20\,000$.
- That gives 14.7 s, which rounds to 15 s.

3(a)	product of force and displacement in direction of force
3(b)	weight/force = mg, and g identified as acceleration of free fall
	ΔE_P identified as work (done by lifting force/weight), and so = $mg \times \Delta h$
3(c)(i)	$240 \times 150 = 36$ kJ
3(c)(ii)	$P = W / t$
	$= 36\,000 / 60$ $= 600$ W
3(c)(iii)	efficiency = <u>useful</u> output power / total input power
	$= 600 / 900$ $= 0.67$
3(c)(iv)	$P = I^2R$ **and** $R = \rho L / A$
	$280 = I^2 \times (1.7 \times 10^{-8} \times 23) / (2.6 \times 10^{-8})$
	$I = 4.3$ A