Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Standard level
Paper 1

Monday 15 May 2017 (afternoon)

45 minutes

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for this examination paper is **[30 marks]**.

2217 – 6510

16 pages

1. What is the unit of electrical energy in fundamental SI units?

A. $\mathrm{kg\,m^2\,C^{-1}\,s}$

B. $\mathrm{kg\,m\,s^{-2}}$

C. $\mathrm{kg\,m^2\,s^{-2}}$

D. $\mathrm{kg\,m^2\,s^{-1}\,A}$

2. Which of the following is a scalar quantity?

A. Velocity

B. Momentum

C. Kinetic energy

D. Acceleration

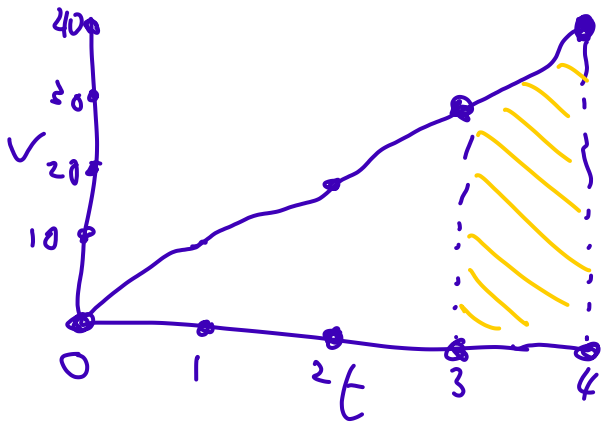
3. An object is released from rest in the gravitational field of the Earth. Air resistance is negligible. How far does the object move during the fourth second of its motion?

A. 15 m

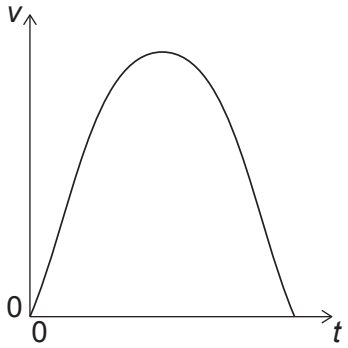
B. 25 m

C. 35 m

D. 45 m

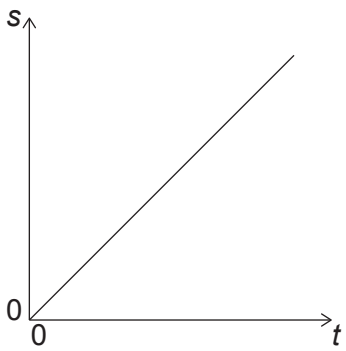


4. The graph shows the variation of speed v of an object with time t.



Which graph shows how the distance s travelled by the object varies with t?

A.



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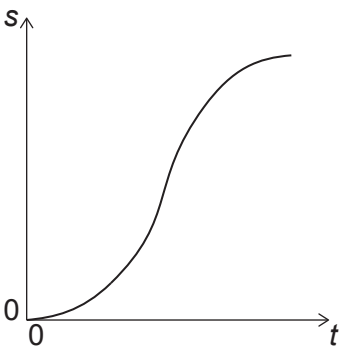

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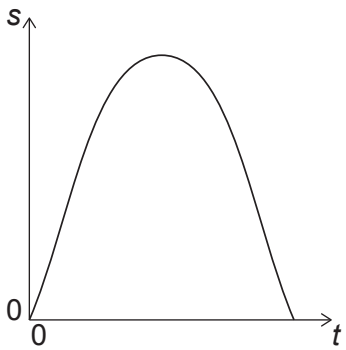

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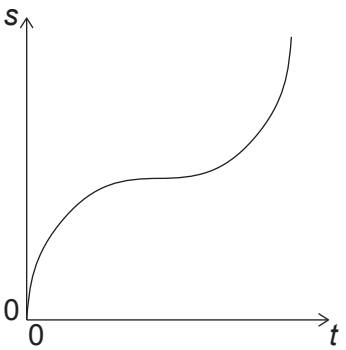
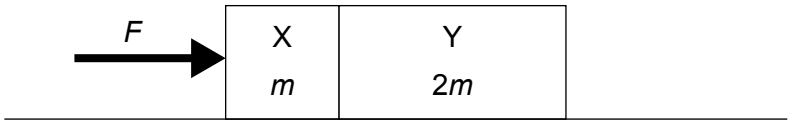


5. Two boxes in contact are pushed along a floor with a force *F*. The boxes move at a constant speed. Box X has a mass *m* and box Y has a mass 2*m*.



What is the resultant force acting on Y?

A. 0

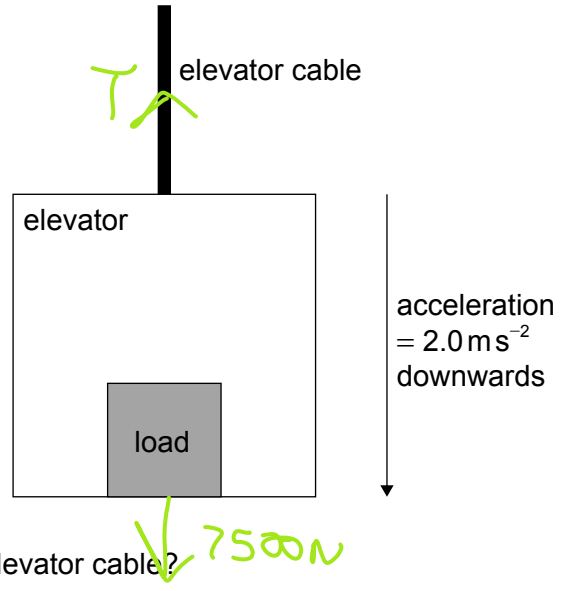
B. $\frac{F}{2}$

C. *F*

D. 2*F*

acceleration = 0 ms^{-2} ∴ 0 F_{NET}

6. An elevator (lift) and its load have a total mass of 750 kg and accelerate vertically downwards at 2.0 ms^{-2}.



What is the tension in the elevator cable?

A. 1.5 kN

B. 6.0 kN

C. 7.5 kN

D. 9.0 kN

$ma = W - T$

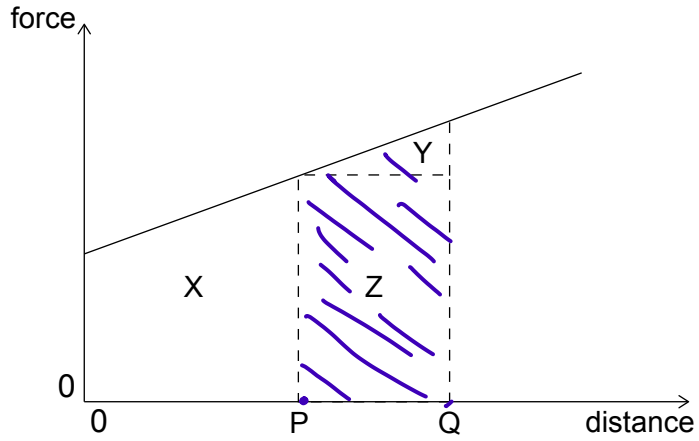
$T = W - ma$

$T = 7500 - (750 \times 2)$

$T = 6000N$

7. A graph shows the variation of force acting on an object moving in a straight line with distance moved by the object.

Which area represents the work done on the object during its motion from P to Q?



A. X

B. Y

C. Y + Z

D. X + Y + Z

8. A car travelling at a constant velocity covers a distance of 100 m in 5.0 s. The thrust of the engine is 1.5 kN.

What is the power of the car?

$P = Fv$ $\quad v = \frac{d}{t}$

$P = 1500 \times 20$ $\quad v = \frac{100}{5} = 20\,ms^{-1}$

$P = 30{,}000\,W$

A. 0.75 kW

B. 3.0 kW

C. 7.5 kW

D. 30 kW

9. An inelastic collision occurs between two bodies in the absence of external forces.

What must be true about the total momentum of the two bodies and the total kinetic energy of the two bodies during this interaction?

A. Only momentum is conserved.

momentum always conserved

B. Only kinetic energy is conserved.

C. Both momentum and kinetic energy are conserved.

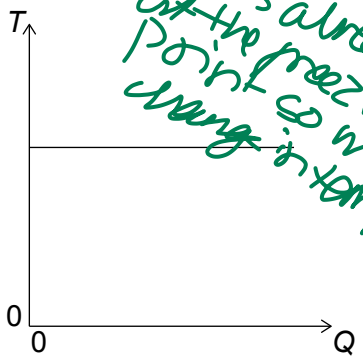
D. Neither momentum nor kinetic energy are conserved.

10. A liquid is initially at its freezing point. Energy is removed at a uniform rate from the liquid until it freezes completely.

Which graph shows how the temperature T of the liquid varies with the energy Q removed from the liquid?

it is already at the freezing point so no change in temp

A.



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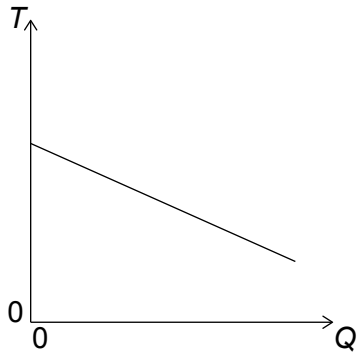

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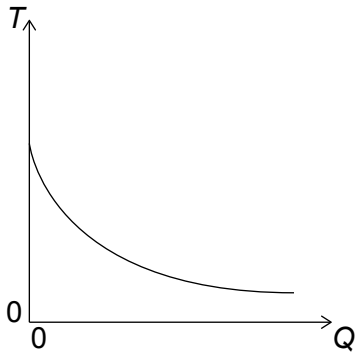

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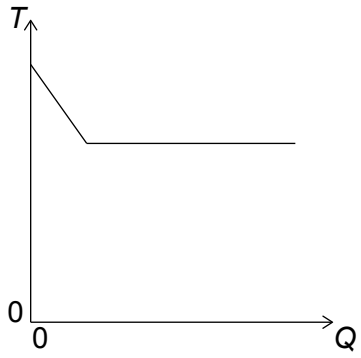
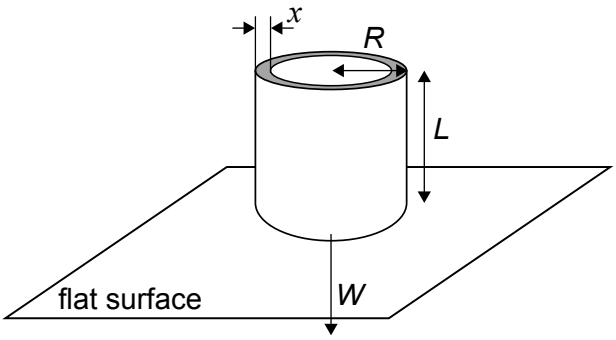


11. A thin-walled cylinder of weight *W*, open at both ends, rests on a flat surface. The cylinder has a height *L*, an average radius *R* and a thickness x where *R* is much greater than x.



What is the pressure exerted by the cylinder walls on the flat surface?

A. $\frac{W}{2\pi Rx}$

B. $\frac{W}{\pi R^2 x}$

C. $\frac{W}{\pi R^2}$

D. $\frac{W}{\pi R^2 L}$

unfold cylinder

$P = \frac{F}{A} = \frac{W}{2\pi Rx}$

12. A fixed mass of an ideal gas in a closed container with a movable piston initially occupies a volume *V*. The position of the piston is changed, so that the mean kinetic energy of the particles in the gas is doubled and the pressure remains constant.

$2T$ P

What is the new volume of the gas?

A. $\frac{V}{4}$

B. $\frac{V}{2}$

C. $2V$

D. $4V$

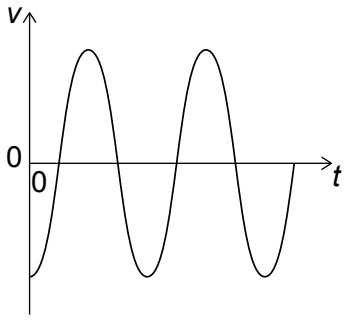
$PV = nRT$

$\frac{PV}{T} = \frac{PV}{T}$

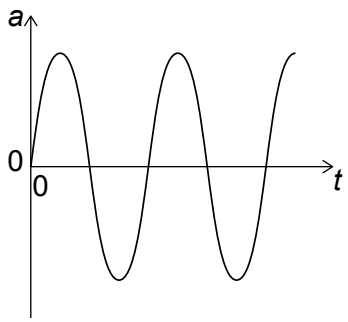
Before = After

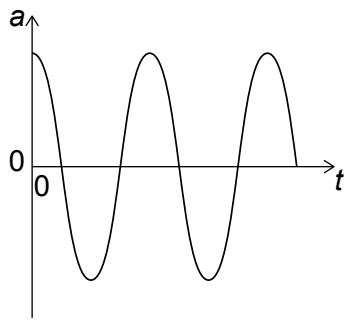
$\frac{PV}{T} = \frac{P(2V)}{2T}$

13. A particle undergoes simple harmonic motion (SHM). The graph shows the variation of velocity v of the particle with time t.



What is the variation with time of the acceleration a of the particle?

A.


B.


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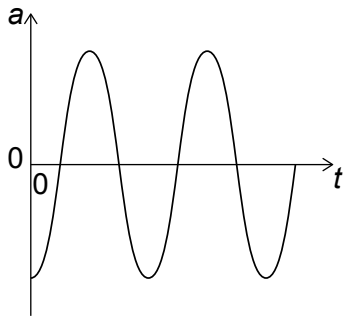
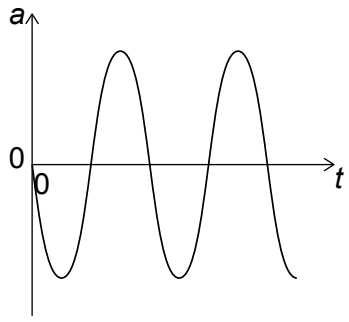


D.


14. What statement about X-rays and ultraviolet radiation is correct?

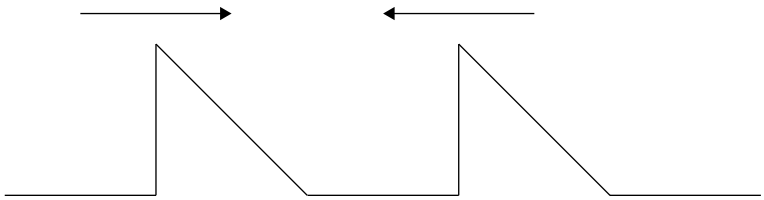
A. X-rays travel faster in a vacuum than ultraviolet waves.

B. X-rays have a higher frequency than ultraviolet waves.

C. X-rays cannot be diffracted unlike ultraviolet waves.

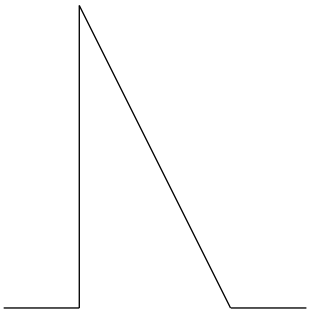
D. Microwaves lie between X-rays and ultraviolet in the electromagnetic spectrum.

15. Two pulses are travelling towards each other.

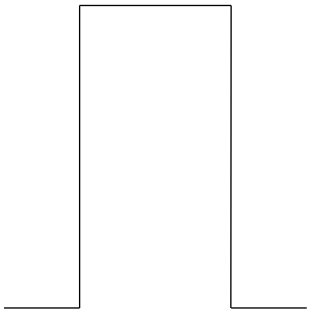


What is a possible pulse shape when the pulses overlap?

A.

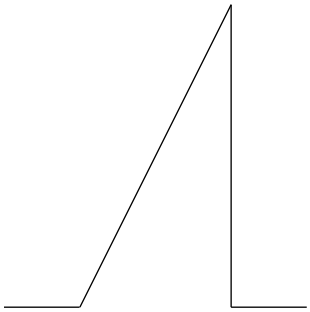


B.



C.

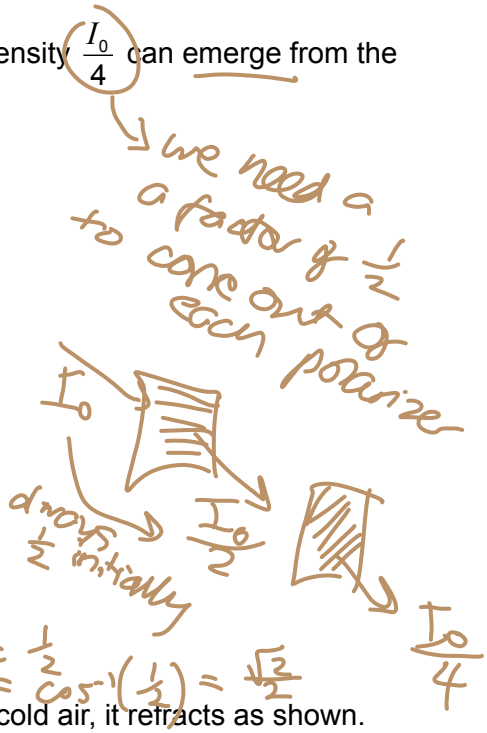
D.



16. Unpolarized light of intensity I_0 is incident on the first of two polarizing sheets. Initially the planes of polarization of the sheets are perpendicular.

Which sheet must be rotated and by what angle so that light of intensity $\frac{I_0}{4}$ can emerge from the second sheet?

	Rotated sheet	Angle of rotation
A.	1 only	$\cos^{-1}\frac{\sqrt{2}}{2}$
B.	2 only	$\cos^{-1}\frac{1}{2}$
C.	1 or 2	$\cos^{-1}\frac{\sqrt{2}}{2}$
D.	1 or 2	$\cos^{-1}\frac{1}{2}$

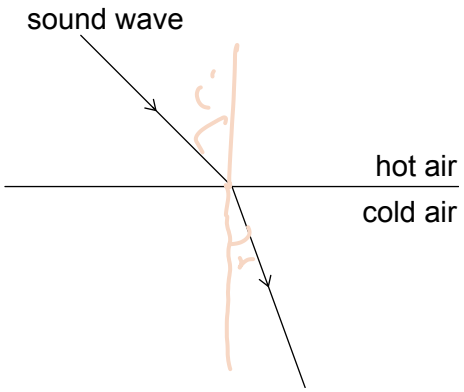


doesn't matter which

$\cos\theta = \frac{1}{2}$

$\theta = \cos^{-1}\left(\frac{1}{2}\right) = \frac{\sqrt{2}}{2}$

17. When a sound wave travels from a region of hot air to a region of cold air, it refracts as shown.



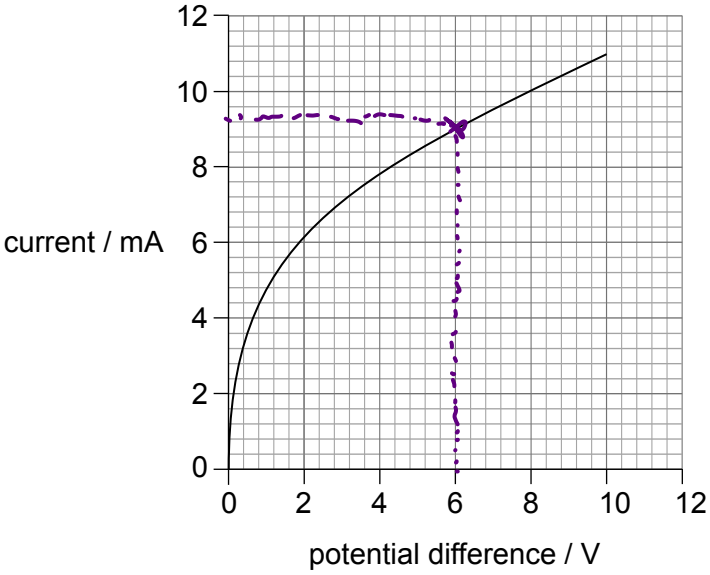
$c = f\lambda$

$\downarrow c = f \downarrow \lambda \downarrow$

What changes occur in the frequency and wavelength of the sound as it passes from the hot air to the cold air?

	Frequency	Wavelength
A.	unchanged	increases
B.	unchanged	decreases
C.	increases	increases
D.	decreases	decreases

18. The graph shows the variation of current with potential difference for a filament lamp.



What is the resistance of the filament when the potential difference across it is 6.0 V?

A. 0.5 mΩ

B. 1.5 mΩ

C. 670 Ω

D. 2000 Ω

$V = IR$

$\frac{V}{I} = R$

$\frac{6}{9 \times 10^{-3}} = R$

$\frac{6000}{9} = 670\,\Omega$

19. An electron is accelerated through a potential difference of 2.5 MV. What is the change in kinetic energy of the electron?

A. 0.4 μJ

B. 0.4 nJ

C. 0.4 pJ

D. 0.4 fJ

$W = Vq$

$= 2.5 \times 10^{6} \times 1.6 \times 10^{-19}$

$\approx 4 \times 10^{-13}$

$\approx 0.4 \times 10^{-12}$

20. A cell is connected in series with a resistor and supplies a current of 4.0 A for a time of 500 s. During this time, 1.5 kJ of energy is dissipated in the cell and 2.5 kJ of energy is dissipated in the resistor.

What is the emf of the cell?

A. 0.50 V

B. 0.75 V

C. 1.5 V

D. 2.0 V

$P = 1V$
$\mathcal{E} = 4V$
$\frac{\mathcal{E}}{4} = 2 Volts$

$P = \frac{E}{t}$
$P = \frac{4000}{500}$
$P = 8W$

21. An electron travelling at speed v perpendicular to a magnetic field of strength B experiences a force F.

What is the force acting on an alpha particle travelling at $2v$ parallel to a magnetic field of strength $2B$?

A. 0

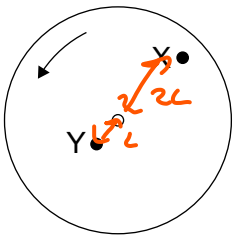
B. $2F$

C. $4F$

D. $8F$

90°!

22. A horizontal disc rotates uniformly at a constant angular velocity about a central axis normal to the plane of the disc.



Point X is a distance $2L$ from the centre of the disc. Point Y is a distance L from the centre of the disc. Point Y has a linear speed v and a centripetal acceleration a.

What is the linear speed and centripetal acceleration of point X?

	Linear speed of X	Centripetal acceleration of X
A.	v	a
B.	$2v$	$2a$
C.	v	$2a$
D.	$2v$	$4a$

23. An object of constant mass is tied to the end of a rope of length l and made to move in a horizontal circle. The speed of the object is increased until the rope breaks at speed v. The length of the rope is then changed. At what other combination of rope length and speed will the rope break?

	Rope length	Speed
A.	$4l$	$2v$
B.	$2l$	v
C.	$2l$	$\frac{v}{2}$
D.	$4l$	$\frac{v}{2}$

24. A nucleus of phosphorus (P) decays to a nucleus of silicon (Si) with the emission of particle X and particle Y.

$$^{30}_{15}\text{P} \rightarrow {}^{30}_{14}\text{Si} + \text{X} + \text{Y}$$

What are X and Y?

	X	Y
A.	antineutrino	positron
B.	antineutrino	electron
C.	neutrino	electron
D.	neutrino	positron

25. What is the definition of the unified atomic mass unit?

A. $\frac{1}{12}$ the mass of a neutral atom of carbon-12

B. The mass of a neutral atom of hydrogen-1

C. $\frac{1}{12}$ the mass of a nucleus of carbon-12

D. The mass of a nucleus of hydrogen-1

26. In nuclear fission, a nucleus of element X absorbs a neutron (n) to give a nucleus of element Y and a nucleus of element Z.

$$\text{X} + \text{n} \rightarrow \text{Y} + \text{Z} + 2\text{n}$$

What is $\frac{\text{magnitude of the binding energy per nucleon of Y}}{\text{magnitude of the binding energy per nucleon of X}}$ and $\frac{\text{total binding energy of Y and Z}}{\text{total binding energy of X}}$?

	$\frac{\text{Magnitude of the binding energy per nucleon of Y}}{\text{Magnitude of the binding energy per nucleon of X}}$	$\frac{\text{Total binding energy of Y and Z}}{\text{Total binding energy of X}}$
A.	greater than 1	greater than 1
B.	less than 1	greater than 1
C.	greater than 1	less than 1
D.	less than 1	less than 1

27. What is the energy equivalent to the mass of one proton?

A. $9.38 \times (3 \times 10^8)^2 \times 10^6\,\text{J}$

B. $9.38 \times (3 \times 10^8)^2 \times 1.6 \times 10^{-19}\,\text{J}$

C. $\frac{9.38 \times 10^8}{1.6 \times 10^{-19}}\,\text{J}$

D. $9.38 \times 10^8 \times 1.6 \times 10^{-19}\,\text{J}$

28. The following are energy sources.

I. a battery of rechargeable electric cells

II. crude oil

III. a pumped storage hydroelectric system

Which of these are secondary energy sources?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

29. Planet X and planet Y both emit radiation as black bodies. Planet X has a surface temperature that is less than the surface temperature of planet Y.

What is the graph of the variation of intensity I with wavelength λ for the radiation emitted by planet Y? The graph for planet X is shown dotted.

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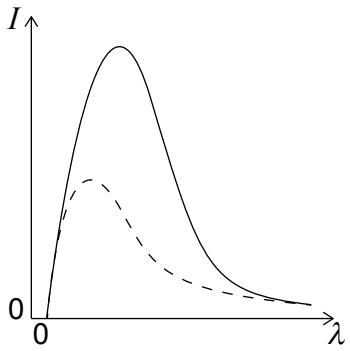
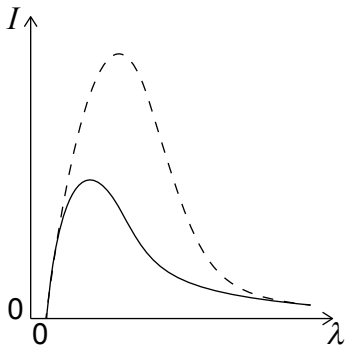


B.


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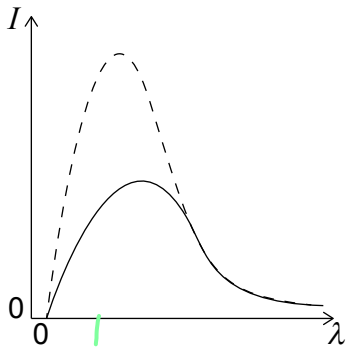

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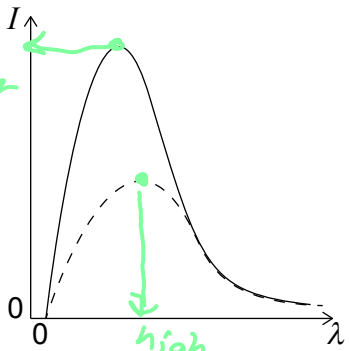

30. The average surface temperature of Mars is approximately 200 K and the average surface temperature of Earth is approximately 300 K. Mars has a radius half that of Earth. Assume that both Mars and Earth act as black bodies.

What is $\frac{\text{power radiated by Mars}}{\text{power radiated by Earth}}$?

A. 20

B. 5

C. 0.2

D. 0.05