M10/4/PHYSI/HPM/ENG/TZ2/XX+

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PHYSICS
HIGHER LEVEL
PAPER 1

Monday 10 May 2010 (afternoon)

1 hour

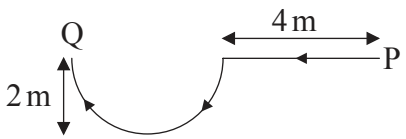
INSTRUCTIONS TO CANDIDATES

- 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.

1. The current in a resistor is measured as 2.00 A ± 0.02 A. Which of the following correctly identifies the absolute uncertainty and the percentage uncertainty in the current?

	Absolute uncertainty	Percentage uncertainty
A.	±0.02 A	±1 %
B.	±0.01 A	±0.5 %
C.	±0.02 A	±0.01 %
D.	±0.01 A	±0.005 %

2. Samantha walks along a horizontal path in the direction shown. The curved part of the path is a semi-circle.



The magnitude of her displacement from point P to point Q is approximately

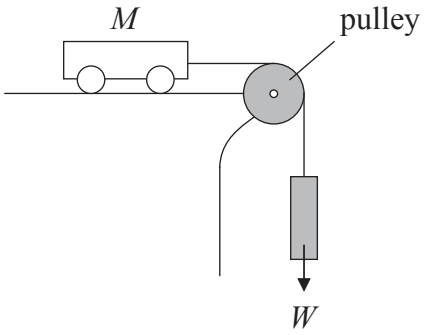
A. 2 m.

B. 4 m.

C. 6 m.

D. 8 m.

3. A cart of mass M is on a horizontal frictionless table.



The cart is connected to an object of weight W via a pulley. Which of the following is the acceleration of the cart?

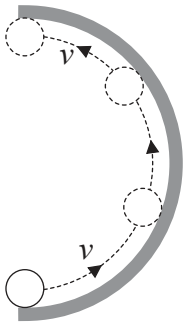
A. $\dfrac{M + \dfrac{W}{g}}{W}$

B. $\dfrac{W}{M + \dfrac{W}{g}}$

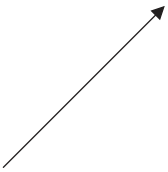
C. $\dfrac{Mg}{W}$

D. 0

4. A ball moves along the inside of a horizontal semi-circular ring as shown. The diagram is a view from above.



Which arrow represents the direction of the average force on the ball?

A. 

B.

C.

D. 

5. A pump extracts water from a well of depth h at a constant rate of R kg s^{-1}. What is the power required to raise the water?

A. $\frac{R}{gh}$

B. Rgh

C. $\frac{Rg}{h}$

D. $\frac{hg}{R}$

6. A box that is at rest with respect to horizontal ground contains a fixed quantity of an ideal gas. The internal energy of the gas is U and its temperature is T. The box is now made to move at constant speed with respect to the ground. Which of the following gives the change, if any, in the internal energy and the temperature of the gas after the box has been moving for some time?

	Internal energy	Temperature
A.	no change	no change
B.	no change	increase
C.	increase	no change
D.	increase	increase

7. Object P has a mass m_P and specific heat capacity c_P. Object Q has a mass m_Q and specific heat capacity c_Q. The temperature of each object increases by the same amount. Which of the following gives the ratio

$$\frac{\text{thermal energy transferred to object P}}{\text{thermal energy transferred to object Q}}?$$

A. $\frac{m_P c_Q}{m_Q c_P}$

B. $\frac{m_P c_P}{m_Q c_Q}$

C. $\frac{m_Q c_Q}{m_P c_P}$

D. $\frac{m_Q c_P}{m_P c_Q}$

8. An ideal gas has pressure p_0 and volume V_0. The number of molecules of the gas is doubled without changing the temperature. What is the new value of pressure times volume?

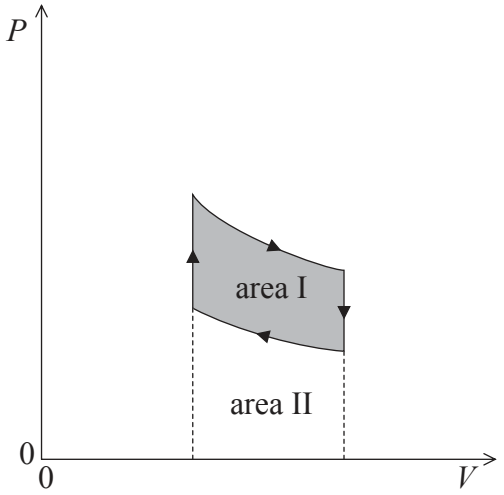
A. $\frac{p_0V_0}{4}$

B. $\frac{p_0V_0}{2}$

C. p_0V_0

D. $2p_0V_0$

9. The diagram shows the pressure–volume (PV) relationship for a gas.



Which of the following area(s) is/are equal to the work done by the gas as it expands?

A. area I

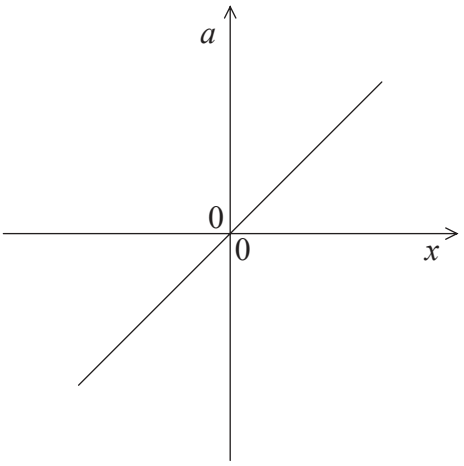
B. area II

C. area I + area II

D. area I – area II

10. The graphs show how the acceleration a of four different particles varies with their displacement x. Which of the particles is executing simple harmonic motion?

A.



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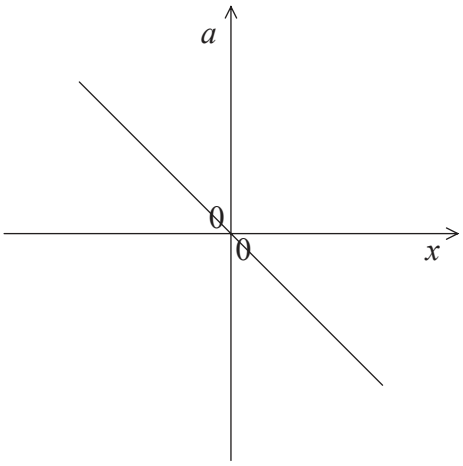
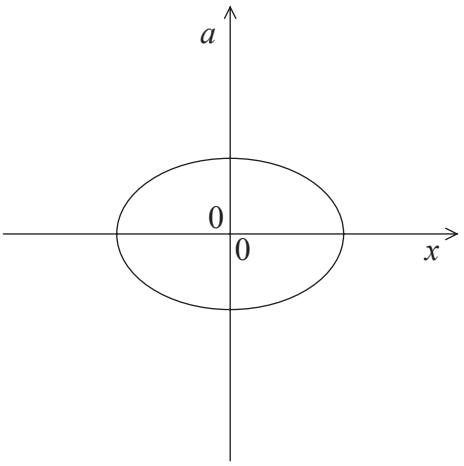
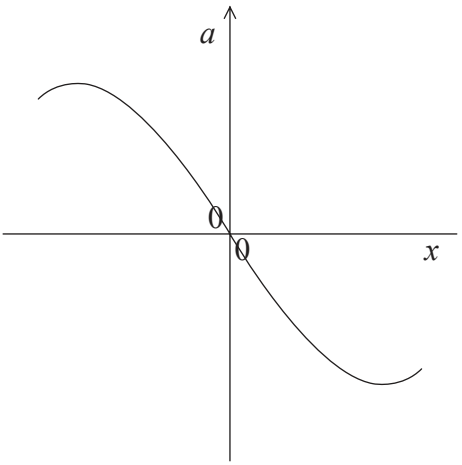


C.



D.



11. The shock absorbers of a car, in good working condition, ensure that the vertical oscillations of the car are

A. undamped.

B. lightly damped.

C. moderately damped.

D. critically damped.

12. An organ pipe of length L is open at one end and closed at the other. Which of the following gives the wavelength of the second harmonic standing wave in the pipe?

A. $\frac{L}{2}$

B. L

C. $4L$

D. $\frac{4L}{3}$

13. A man standing by the shore observes sea waves approaching at a frequency of 0.20 Hz. A man on a boat observes that waves are approaching the boat at a frequency of 0.50 Hz. The speed of the waves is $2.0\,\text{m}\,\text{s}^{-1}$. Which of the following gives a possible value for the speed of the boat and its direction?

	Speed / $\text{m}\,\text{s}^{-1}$	Direction
A.	3.0	away from the shore
B.	3.0	towards the shore
C.	1.2	away from the shore
D.	1.2	towards the shore

14. In a monochromatic liquid crystal display (LCD), such as those used in calculators, the purpose of the liquid crystal is to

A. change colour from white to black when a segment is to be displayed.

B. lubricate the small gap between the plates to prevent overheating.

C. rotate the plane of polarization of the light passing through it.

D. act as a conducting pathway between the segment electrodes.

15. A parallel beam of light with a wavelength 600 nm passes through a single narrow slit and forms a diffraction pattern on a screen. The angle at which the first diffraction minimum is formed is 2.0×10^{-3} rad.

What would be the angle of the first diffraction minimum for light of wavelength 400 nm?

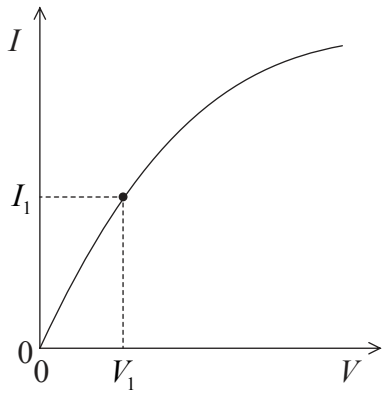
A. 3.0×10^{-3} rad

B. 2.0×10^{-3} rad

C. 1.3×10^{-3} rad

D. 1.2×10^{-3} rad

16. The graph shows how the current I in a resistor varies with the voltage V applied across it.



Which of the following gives the resistance of the resistor, when $I = I_1$?

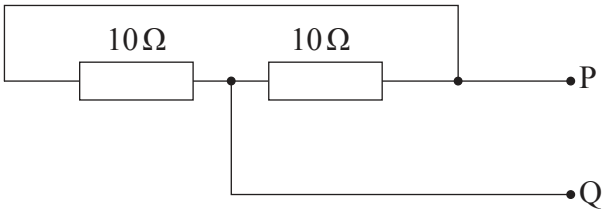
A. $\frac{V_1}{I_1}$

B. The slope of the curve at the point (V_1, I_1)

C. $\frac{I_1}{V_1}$

D. The inverse of the slope of the curve at the point (V_1, I_1)

17. Two 10 Ω resistors are connected as shown.



What is the resistance across PQ?

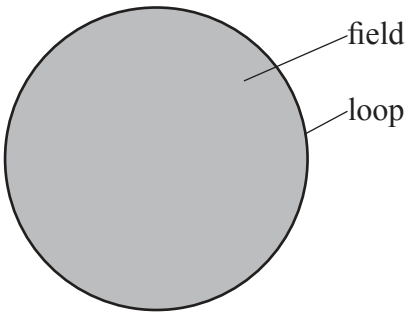
A. 0 Ω

B. 5 Ω

C. 10 Ω

D. 20 Ω

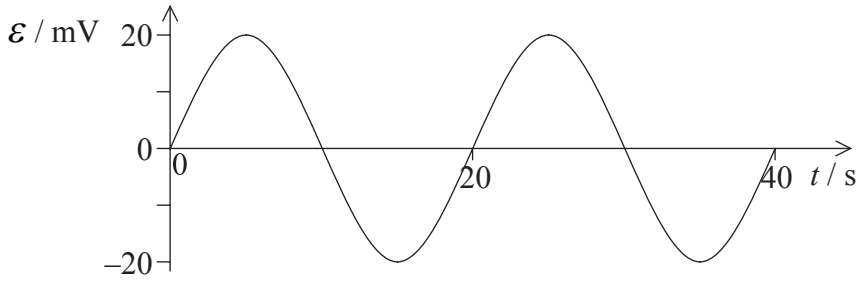
18. A uniform magnetic field is perpendicular to the plane of a loop of conducting wire.



The field is directed out of the plane of paper. The magnitude of the magnetic field is decreasing at a constant rate. Which of the following gives the correct state and correct direction of the current in the wire?

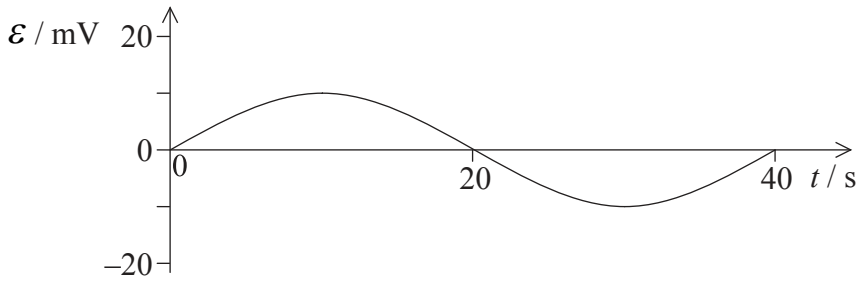
	Current	Direction
A.	varying	clockwise
B.	constant	clockwise
C.	varying	counter-clockwise
D.	constant	counter-clockwise

19. The graph shows the variation of the induced emf ε of a generator as a function of time.

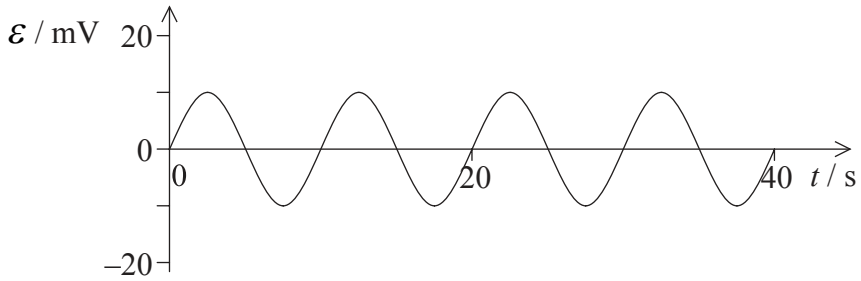


The frequency of rotation of the generator is halved. Which of the following graphs correctly shows the variation of the new induced emf ε as a function of time?

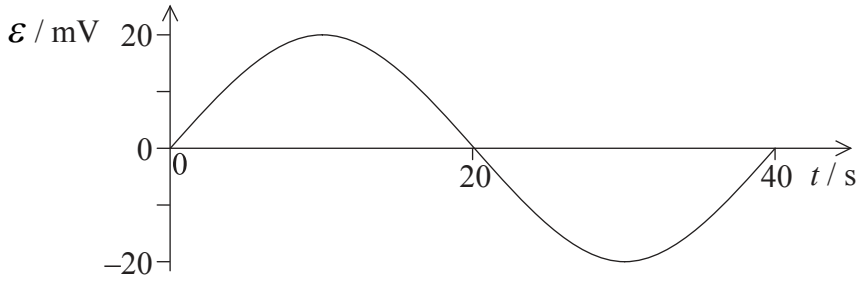
A.



B.



C.



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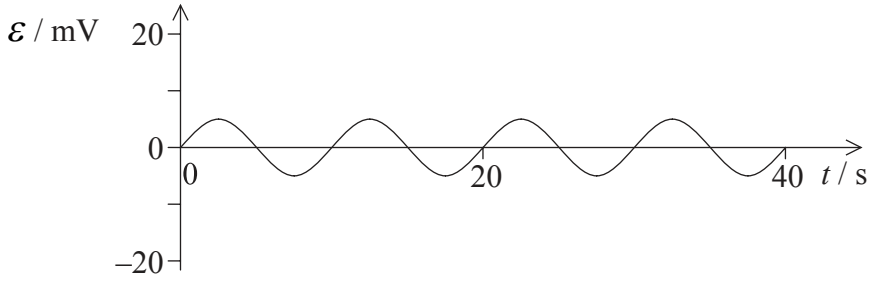
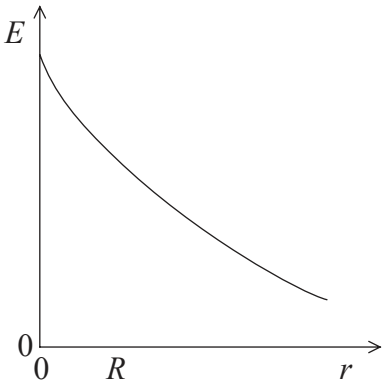
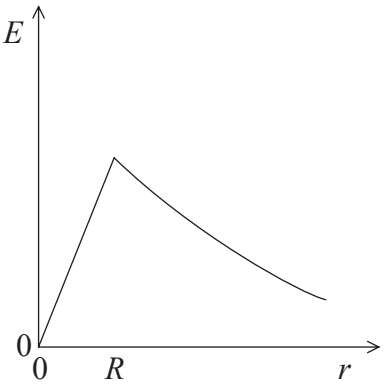


20. The radius of a charged spherical conductor is R. Which of the following graphs best shows how the magnitude of the electrical field strength E varies with distance r from the centre of the sphere?

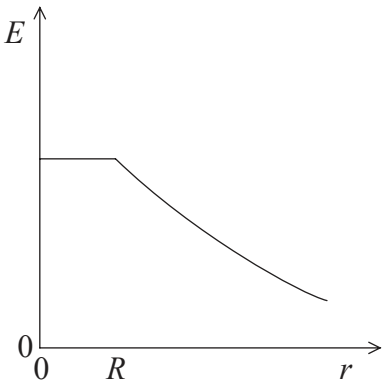
A.



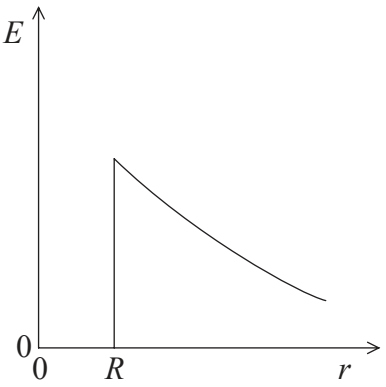
B.



C.



D.



21. Which of the following is true about gravitational field lines?

A. They are always tangential to equipotential surfaces.

B. They are always perpendicular to equipotential surfaces.

C. They can be both tangential or perpendicular to equipotential surfaces.

D. They can have any angle to the equipotential surfaces.

22. Which of the following is true about the gravitational potential V due to a point mass at a distance r from the point mass?

A. $V \propto \frac{1}{r}$ and always positive

B. $V \propto \frac{1}{r}$ and always negative

C. $V \propto \frac{1}{r^2}$ and always positive

D. $V \propto \frac{1}{r^2}$ and always negative

23. An astronaut in orbit around Earth is said to be "weightless". This is due to the fact that the

A. gravitational force on the astronaut is zero.

B. astronaut and the spacecraft experience the same acceleration.

C. astronaut and the spacecraft experience the same gravitational force.

D. gravitational field at the position of the spacecraft is zero.

24. Which of the following decay sequences would result in the daughter nucleus having the same proton number as the parent nucleus?

A. Alpha followed by gamma

B. Beta (β^-) followed by gamma

C. Alpha followed by beta (β^-) followed by beta (β^-)

D. Beta (β^-) followed by gamma followed by gamma

25. The difference between the mass of a $^{12}_{6}C$ nucleus and the sum of the masses of the individual nucleons is 0.1 u. Which of the following is approximately the binding energy of the nucleus?

A. 90 MeV

B. 90 $MeV\,c^{-2}$

C. 8 MeV

D. 8 $MeV\,c^{-2}$

26. A radioactive source emits alpha particles that then travel through air. With reference to the range of the alpha particles consider the following three quantities.

I. The charge of the alpha particle

II. The kinetic energy of the alpha particle

III. The density of the air

Which of the above determines the range of the alpha particles?

A. I only

B. II only

C. I and II only

D. I, II and III

27. Photoelectron emission only occurs if the light incident on a metal surface is

A. coherent.

B. above a certain minimum intensity.

C. below a certain minimum frequency.

D. below a certain minimum wavelength.

28. Electrons are accelerating from rest through a potential difference of V. The de Broglie wavelength λ of the electrons is proportional to which of the following?

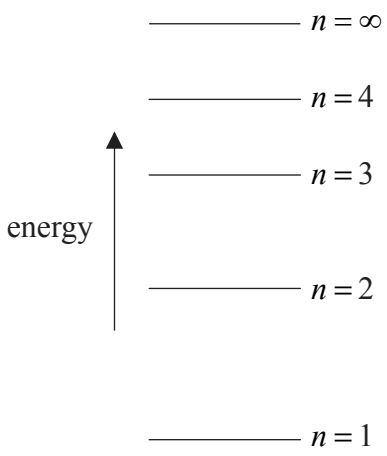
A. V

B. $\frac{1}{V}$

C. $\sqrt{V}$

D. $\frac{1}{\sqrt{V}}$

29. The diagram shows some of the energy levels of a hypothetical atom.



The atom is excited to the energy level $n = 4$. Which of the following transitions will produce a photon of the longest and the shortest wavelength?

	Longest wavelength	Shortest wavelength
A.	4 → 3	4 → 1
B.	4 → 1	4 → 3
C.	2 → 1	4 → 3
D.	4 → 3	2 → 1

30. In the Schrödinger model of the hydrogen atom, it is assumed that electrons

A. are massless particles.

B. are waves.

C. oscillate.

D. can be described by wave functions.

31. The energy of α-particles in α-decay and the energy of γ-rays in γ-decay are discrete. This provides evidence for the existence of

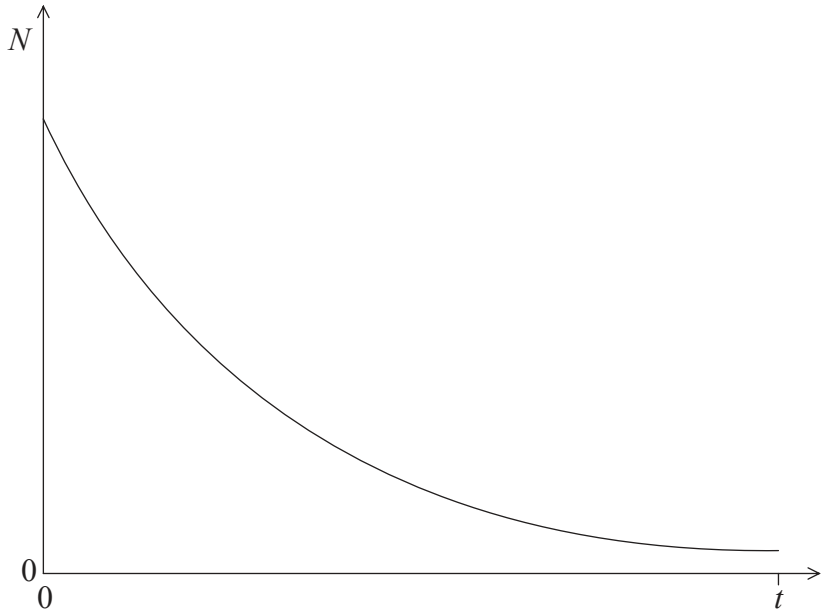
A. nuclear energy levels.

B. neutrinos.

C. atomic energy levels.

D. isotopes.

32. The graph below shows the number of nuclei N of a radioactive isotope as a function of time t.



The slope of the curve at any given time is

A. independent of the decay constant.

B. proportional to the half-life of the isotope.

C. proportional to the number of radioactive nuclei remaining at that time.

D. proportional to the number of radioactive nuclei decayed.

33. Which of the following correctly shows a renewable and a non-renewable source of energy?

	Renewable	Non-renewable
A.	oil	geothermal
B.	wind	biofuels
C.	ocean waves	nuclear
D.	natural gas	coal

34. Worldwide, the use of gas powered turbines is becoming more common than the use of oil powered turbines. A student makes the following three statements about gas powered turbines as compared to oil powered turbines.

I. They are more efficient.

II. They produce more thermal energy per unit of mass.

III. They produce less CO_2 per unit of output energy.

Which statement(s) could be a possible reason for favouring gas powered turbines?

A. I only

B. II only

C. I and II only

D. I, II and III

35. Critical mass refers to the amount of fissile material that

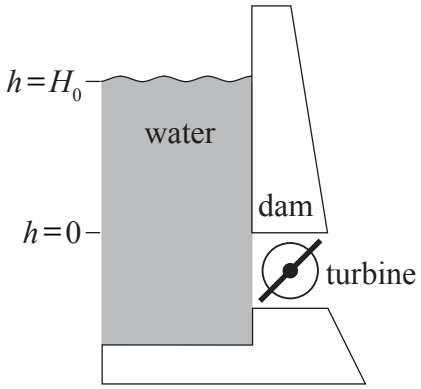
A. will allow fission to be sustained.

B. is equivalent to 235 g of uranium.

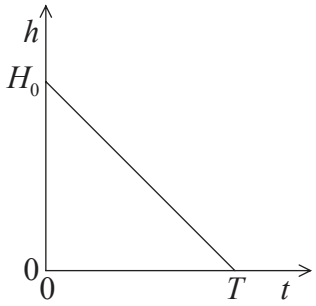
C. will produce a growing chain reaction.

D. is the minimum mass necessary for fission to take place.

36. The water in a reservoir behind a dam drops from an initial height H_0 above a turbine to produce hydroelectricity. At time $t = T$, $h = 0$.



The graph shows the variation with time t of the height h of the water above the turbine.



Which of the following is a measure of the maximum theoretical electric power available?

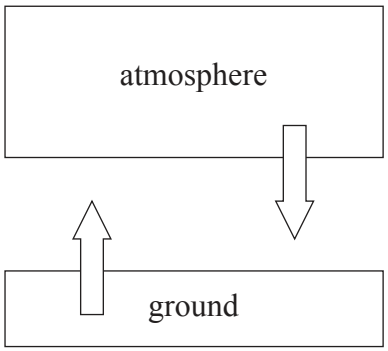
A. H_0 and the slope of the graph

B. T and the slope of the graph

C. T and the area under the graph

D. H_0 and the area under the graph

37. The diagram shows a simple climate model for Earth. The temperature of the ground is T_g and is assumed to radiate as a black body. The temperature of the atmosphere is T_a and has an emissivity ε.



In the model, the intensity radiated from the ground equals the intensity radiated from the atmosphere towards the ground. What is the ratio $\frac{T_g}{T_a}$?

A. ε^4

B. ε

C. $\varepsilon^{\frac{1}{4}}$

D. 1

38. To retrieve information stored on a CD, light of wavelength 800 nm is used. To retrieve information stored on a DVD, light of wavelength 400 nm is used.

Which of the following gives the ratio $\frac{\text{pit height of the CD}}{\text{pit height of the DVD}}$?

A. 8

B. 2

C. 1

D. 0.5

39. N photons are incident on a pixel of a CCD. Each photon causes one electron of charge e to be emitted. The capacitance of the pixel is C. What is the resulting potential difference across the pixel?

A. NeC

B. $\frac{C}{Ne}$

C. $\frac{Ne}{C}$

D. $\frac{Ce}{N}$

40. The linear magnification of a digital camera is M. The length of one side of a pixel is l. A picture of two points of an object separated by a distance D is taken.

The images of the points will be resolved on the CCD if the ratio $\frac{MD}{l}$ is

A. smaller than 1.

B. equal to 1.

C. equal to 2 or more.

D. at least 10 or more.