

A Level Physics A
H556/01 Modelling physics

Question Set 3

Multiple Choice Questions

1 Which of the following is a correct unit for gravitational field strength?

- A J kg^{-1}
- B N kg^{-1}
- C $\text{Nm}^2 \text{kg}^{-2}$
- D kgms^{-1}

$$W = mg$$

$$\frac{W}{m} = g$$

$$\frac{\text{N}}{\text{kg}} \rightarrow g$$

Your answer

B

[1]

2 The intensity against wavelength graph of an object at 750°C peaks at a wavelength of λ . The temperature of the object is raised to 960°C .

What is the wavelength now at the new peak intensity in terms of λ ?

- A 0.78λ
- B 0.83λ
- C 1.2λ
- D 1.3λ

Convert temperatures into Kelvin \rightarrow

$$750^\circ\text{C} = 1023.15 \text{ K}$$

$$960^\circ\text{C} = 1233.15 \text{ K}$$

$$\lambda = \frac{k}{T} \quad \text{so} \quad \lambda_1 T_1 = \lambda_2 T_2$$

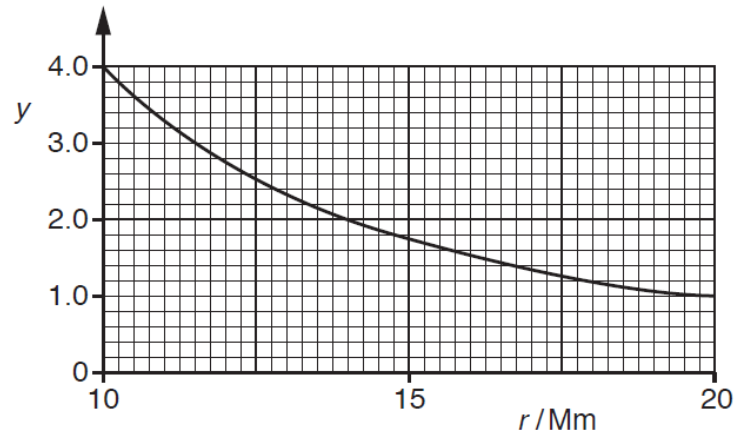
$$\lambda_2 = \frac{1023.15}{1233.15} \lambda_1 = 0.83\lambda_1$$

Your answer

B

[1]

3 A graph of y against distance r from the centre of a planet is shown below.



The graph shows that y is inversely proportional to r^2 .

Which quantity is best represented on the y -axis of the graph?

- A Period of a satellite orbiting the planet.
- B Gravitational potential of the planet.
- C Gravitational field strength of the planet.
- D Kinetic energy of a satellite orbiting the planet.

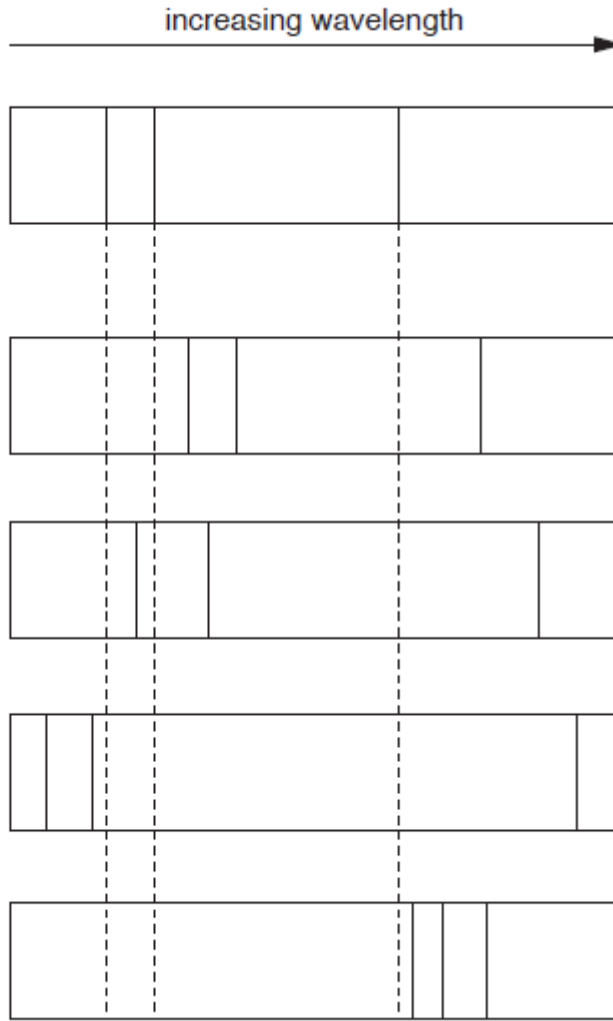
Your answer

B

[1]

4 Part of the line spectrum for light from the Sun is shown below.

Which spectrum best shows light from a similar star to the Sun?



Higher λ_s
are red-shifted
more.

Your answer

B

[1]

- 5 A container has an ideal gas. The mean square speed of the gas molecules in the container is $3.0 \times 10^5 \text{ m}^2 \text{ s}^{-2}$.

Over a period of time, a third of the gas molecules escape from the container. The pressure and volume of the gas in the container remain the same.

What is the mean square speed of the molecules left in the container?

A $1.0 \times 10^5 \text{ m}^2 \text{ s}^{-2}$

B $2.0 \times 10^5 \text{ m}^2 \text{ s}^{-2}$

C $4.5 \times 10^5 \text{ m}^2 \text{ s}^{-2}$

D $9.0 \times 10^5 \text{ m}^2 \text{ s}^{-2}$

$$pV = \frac{1}{3} Nm \overline{c^2}$$

$$\overline{c^2} \propto \frac{1}{N}$$

Your answer

C

[1]

- 6 Which two quantities are related in Hubble's law?

A Distance and mass of galaxies.

B Velocity and intensity of galaxies.

C Distance and velocity of galaxies.

D Distance and red shift of stars in our galaxy.

Your answer

C

[1]

- 7 A metal block of mass 0.28 kg has an initial temperature of 82°C . It is dropped into cold water. The temperature of the block after 1.2 minutes is 20°C . The specific heat capacity of the metal is $130 \text{ J kg}^{-1} \text{ K}^{-1}$.

What is the average thermal power transferred away from the metal block?

A 31 W

B 41 W

C 1900 W

D 2700 W

$$P = \frac{E}{t}$$

$$E = mc\Delta\theta$$

$$\therefore P = \frac{mc\Delta\theta}{t}$$

Your answer

A

[1]

$$t = 1.2 \times 60 = 72$$

$$P = \frac{0.28 \times 130 \times (82 - 20)}{72}$$

$$P = 31.3\dot{4} = 31 \text{ W}$$

- 8 The acceleration a of a simple harmonic oscillator is related to its displacement x by the equation

$$a = -25x.$$

What is the frequency of the oscillator?

- A 0.80 Hz
- B 1.3 Hz
- C 4.0 Hz
- D 5.0 Hz

$$a = -\omega^2 x$$

$$\omega^2 = 25$$

$$\omega = 5 \text{ Hz}$$

Your answer

D

[1]

- 9 The latent heat of vaporisation of a liquid is 2300 kJ kg^{-1} and it has a molar mass of $0.018 \text{ kg mol}^{-1}$.

What is the energy required to change 30 moles of the liquid to gas?

- A $4.1 \times 10^4 \text{ J}$
- B $1.2 \times 10^6 \text{ J}$
- C $6.9 \times 10^7 \text{ J}$
- D $3.8 \times 10^9 \text{ J}$

$$\text{Mass is } 0.018 \times 30 = 0.54 \text{ kg}$$

$$E = mL$$

$$E = 0.54(2300 \times 10^3)$$

$$= 1242000$$

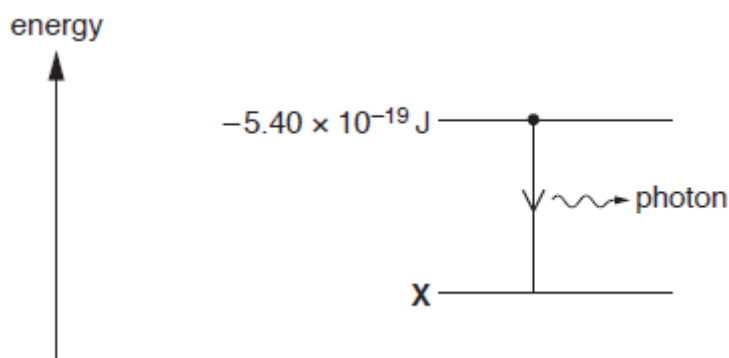
$$= 1.2 \times 10^6 \text{ J}$$

Your answer

B

[1]

10 An electron makes a transition between the two energy levels shown below.



This transition produces a photon of frequency $4.10 \times 10^{14} \text{ Hz}$.

What is the value of the energy level X?

- A $-2.68 \times 10^{-19} \text{ J}$
- B $-2.72 \times 10^{-19} \text{ J}$
- C $-5.40 \times 10^{-19} \text{ J}$
- D $-8.12 \times 10^{-19} \text{ J}$

$$E = hf$$
$$E = 6.63 \times 10^{-34} \times 4.1 \times 10^{14}$$
$$= 2.72 \times 10^{-19}$$

Your answer

D

[1]

11 A pendulum is oscillating in air and experiences damping.

Which of the following statements is/are correct for the damping force acting on the pendulum?

- 1 It is always opposite in direction to acceleration.
 - 2 It is always opposite in direction to velocity.
 - 3 It is maximum when the displacement is zero.
- A Only 1 and 2
 - B Only 2 and 3
 - C Only 3
 - D 1, 2 and 3

Your answer

B

[1]

- 12 Earth has a mass of 6.0×10^{24} kg and a radius of 6400 km. A satellite of mass 320 kg is lifted from the Earth's surface to an orbit 1200 km above its surface.

What is the change in the gravitational potential energy of the satellite?

- A 9.1×10^2 J
 B 9.9×10^6 J
 C 3.2×10^9 J
 D 3.8×10^9 J

$$\Delta GPE = \frac{GMm}{r_1 + r_2} - \frac{GMm}{r_1}$$

$$\Delta GPE = 6 \times 10^{24} \times 320 \times 6.67 \times 10^{-11} \left(\frac{1}{(6400+1200) \times 10^3} - \frac{1}{6400 \times 10^3} \right)$$

$$\Delta GPE = -3.2 \times 10^9 \text{ J}$$

Your answer

C

[1]

- 13 The volume of one mole of an ideal gas is V . The gas exerts pressure p and has thermodynamic temperature T .

Which of the following has the units $\text{J mol}^{-1} \text{K}^{-1}$?

- A pV
 B $\frac{p}{T}$
 C $\frac{V}{T}$
 D $\frac{pV}{T}$

where $n=1$

$$pV = RT$$

$$R = \frac{pV}{T} = \text{J mol}^{-1} \text{K}^{-1}$$

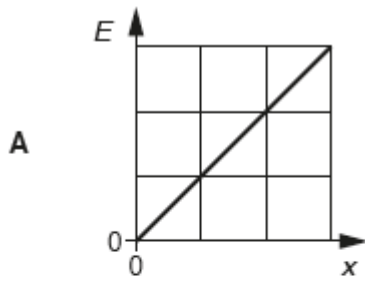
Your answer

D

[1]

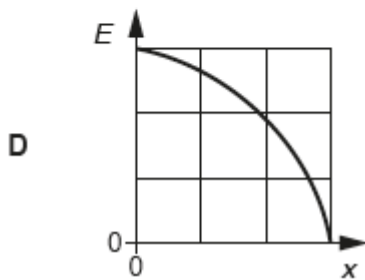
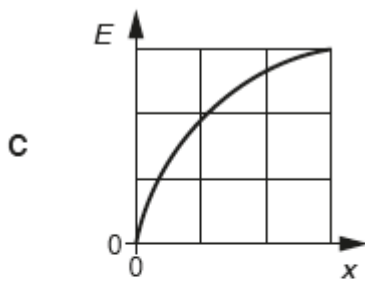
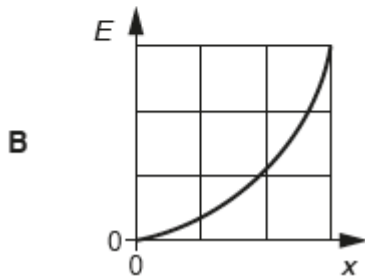
14 An object oscillates with simple harmonic motion.

Which graph **best** shows the variation of its potential energy E with distance x from the equilibrium position?



E.g. spring

$$E = \frac{1}{2} k x^2$$



Your answer

B

[1]

15 A simple harmonic oscillator has maximum speed 24 m s^{-1} and amplitude 5.6 cm .

What is its angular frequency?

- A 0.23 rad s^{-1}
- B 21 rad s^{-1}
- C 68 rad s^{-1}
- D 430 rad s^{-1}

$$V_{\text{MAX}} = \omega A$$

$$24 = \omega \times 5.6 \times 10^{-2}$$

$$\frac{24}{5.6 \times 10^{-2}} = \omega = 428.57 \text{ rad s}^{-1}$$

Your answer

D

[1]

16 The Earth is surrounded by a gravitational field.

Which of the following statements is/are correct about the gravitational field lines near the **surface** of the Earth.

- 1 They are parallel.
 - 2 They show the direction of the force on a small mass.
 - 3 They are equally spaced.
- A Only 1
 - B Only 1 and 2
 - C Only 2 and 3
 - D 1, 2 and 3

Your answer

D

[1]

17 A solid molecular substance is supplied with energy and it starts to melt.

Which of the following pairs of quantities remains the same as the substance melts?

- A Kinetic energy of molecules and internal energy of molecules.
- B Potential energy of molecules and internal energy of molecules.
- C Kinetic energy of molecules and temperature of substance.
- D Potential energy of molecules and temperature of substance.

Your answer

C

[1]

- 18 A student has collected some data on the Solar System.
The student plots a graph, but only two data points are shown below.



The distance from the centre of the Sun is r .

Which quantity y is represented on the vertical axis?

- A Speed of a planet. ✗
- B Period of a planet.
- C Gravitational potential of the Sun. ✗
- D Gravitational field strength of the Sun. ✗

Your answer

B

[1]

- 19 Which column **A**, **B**, **C** or **D**, shows the correct sequence for the evolution of the Universe between the Big Bang and the formation of stars?

A	B	C	D
Universe starts to expand ↓ quarks and leptons form ↓ hadrons form ↓ nuclei form ↓ atoms form	Universe starts to expand ↓ hadrons form ↓ quarks and leptons form ↓ nuclei form ↓ atoms form	quarks and leptons form ↓ nuclei form ↓ Universe starts to expand ↓ atoms form ↓ hadrons form	quarks and leptons form ↓ hadrons form ↓ Universe starts to expand ↓ nuclei form ↓ atoms form

Your answer

A

[1]

20 Some stars will evolve into white dwarfs.

The mass of the Sun is 2.0×10^{30} kg.

Which of the following **cannot** be the mass of a white dwarf?

- A 1.2×10^{30} kg
- B 2.0×10^{30} kg
- C 2.7×10^{30} kg
- D 3.2×10^{30} kg

Chandrasekhar limit:

$$1.4 \times 2.0 \times 10^{30} = 2.8 \times 10^{30}$$

Max limit For a white dwarf

Your answer

D

[1]

21 An astronomer analyses the light from a distant galaxy.

One of the spectral lines in the spectrum observed from the galaxy has wavelength 610 nm. The same spectral line has a wavelength of 590 nm when measured in the laboratory.

What is the speed of this galaxy?

- A 9.8×10^6 m s⁻¹
- B 1.0×10^7 m s⁻¹
- C 2.9×10^8 m s⁻¹
- D 3.0×10^8 m s⁻¹

$$V = H_0 d$$

$$V = \frac{\Delta \lambda c}{\lambda}$$

$$V = \frac{20 \times 10^{-9} \times 3 \times 10^8}{590 \times 10^{-9}} = 1.0 \times 10^7 \text{ m s}^{-1} \quad [1]$$

Your answer

B

Total Marks for Question Set 3: 21



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